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Forthcoming Events.

NOVEMBER 9.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Substitutes for Platinum," Paper by E. A. Smith, A.R.S.M.

The Manchester Association of Engineers:—Ordinary meeting in Manchester. "Crushing of Materials," Paper by J. R. Birch.

Association of Engineers (Barrow and District):—Ordinary meeting at Barrow. "Centrifugal Pumps and their Adaptability," Paper by W. F. Clement.

NOVEMBER 12.

Institute of Metals (Scottish Local Section):—Ordinary meeting at Glasgow. "Nickel Alloys," Paper by D. Turner.

NOVEMBER 13.

Institution of Petroleum Technologists:—General meeting in London. "Galician-Canadian Pale Tool Fishing Methods," Paper by Albert Millar.

Institute of Metals (Birmingham Local Section):—Ordinary meeting at Birmingham. "X-rays and Crystal Structure," Paper by H. B. Keene, D.Sc.

Institute of Marine Engineers:—Adjourned discussion on the Paper, "A Note upon Cast Iron for Marine Engine Castings from the Metallurgical and Engineering Point of View," Paper by Messrs. J. Young and E. Wood.

Institute of Metals (North-East Coast Local Section):—Ordinary meeting at Newcastle-on-Tyne. "General Scientific Brass Foundry Work," Paper by P. Longmuir, D.Met., D.Sc.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

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Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Hardness of Moulds.

Mr. C. Dicken, in his presidential address to the Coventry Branch of the Institute of British Foundrymen, lamented the absence of a mould hardness testing machine. Such an instrument, the invention of Mons. Ronceray, was exhibited at the Paris Conference, and was also inspected by the members of the London Branch last Thursday during the course of a Paper on "Continental Moulding Practice" by Mr. A. S. Beech. Basically, the instrument is on the same principle as the Brinell machine, and consists of a tube containing an adjustable spring pressing on to a ball. This ball is pressed on to a rammed mould surface, and the diameters of the impressions compared. At the moment we are not aware that any strict standards have been established, it being left to any individual worker to make his own.

There are so many aspects of hardness that it would seem desirable to remind foundrymen that this particular type of hardness, when obtained from working with metals, can be more easily correlated to tensile strength than to machinability.

Mineralogic hardness, as determined by the scratch test, is designated by numbers on Mohr's scale. It is a method easily to visualise, but has little engineering association. The results obtained from Schore's method of measuring hardness by the height of rebound of hardened steel balls when allowed to fall under standard conditions are sometimes rendered difficult of interpretation, as the thickness of the sample will influence them. Sealing wax is shown to be hard by this method and soft by the Brinell. Perhaps one of the tests obtained from the new E. G. Herbert pendulum method bears the closest relationship to machinability of any so far devised. Some special steels are incapable of being machined, not because they are hard in most senses, but because they are so exceptionally tough. Having touched upon the various types of hardness, the question arises as to the particular sort to which a moulder refers when speaking of a hard-rammed mould. Surely in this case it refers to an over-compressed mould, which has materially reduced the gas permeability. Now with the permeability are associated the factors of grain size and shape, the amount of silt present, the nature of the bond and other considerations. Will Mons. Ronceray's instrument make any results expressed in figures internationally comparable? We should doubt it, but it should certainly be capable of showing up differences in the strengths of ramming in various parts of a mould. Additionally, with a carefully-prepared standard sand, preferably synthetically produced, it should be possible to make diagrams of the result of (1) pressing sand in one direction; (2) in two opposite directions; (3) with pressing plates partially and completely covering the mass of sand to be compressed; and (4) with jar-ramming at various speeds and intensities. Such diagrams would be of the utmost value to the foundryman, providing that they are based on really comparative figures. Once established, a research could be conducted upon bond, grain-size and other variables upon the "elasticity" of sand. By elasticity we mean the power that a body of sand possesses to communicate to a surrounding bass any applied force.

We consider the potentialities of this little instrument to be of real importance, and we express the hope that a set of standards will be evolved in such a manner that no arithmetic will have to be done to convert various modes of expression into those domestically or nationally used.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Neglected Foundry Educational Facilities.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In your Journal of October 25 there is a leading article on "Neglected Foundry Educational Facilities," and with respect to the fees that are generally required for classes, the cost given of from 5s. to 7s. 6d. is, I think, about the average. They should not, to my mind, be increased; but whether or not they are increased I do not think it would make any difference in the general attendances.

Your statement that some of the classes are better attended where the fees are higher is to be associated with local conditions, and perhaps should not be taken as a criterion.

There are in this district evening classes, both elementary and advanced, and we have as many as from 20 to 25 in each class. The fee here is only 5s. Apparently this attendance is not general, but I am inclined to think the missing incentive is some *definite national examination* on foundry practice, as it would provide the student with something really worth while. In other subjects, such as machine construction, there are recognised examinations. In foundry practice I know of none. This point is one which requires developing, and I believe that if we had this the classes would be better attended.

Yours, etc.,

J. H. LIST.

Works Manager, Meadow Foundry Co., Ltd., Mansfield.

The Late Dr. J. E. Stead.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The death of Dr. Stead, on October 31, means the loss to this nation of one who for 50 years or more has been our greatest metallurgist.

Much of his best work went unsung and unrewarded. What he did for us during the War, as compared with what many did who gained great honour or much wealth, is one only of the many proofs of his unselfish honesty of purpose.

He was always a dear friend to every young man who had the good fortune to meet him, and, nevertheless, a pioneer in whose footprints foundrymen and metallurgists generally are walking to-day.

Should the Institute of British Foundrymen ever desire to erect a lasting memorial to anybody, they will find no one more worthy than Dr. Stead. I trust that at the next meeting of every Branch full honours will be accorded to the memory of this great and good man.

Yours, etc.,

H. J. YOUNG.

16, Ashfield Grove,
Whitley Bay,
Northumberland.
November 1, 1923.

Oil Sand Cores.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your report of the discussion of "Oil Sand Cores," before the Birmingham Branch of the Institute of British Foundrymen, is to us, as manufacturers of core oils, and sand mixers, extremely interesting. We appreciate the difficulties with which the core maker has to contend, and ranges of oils have been produced to help him.

Most foundrymen are aware that linseed oil varies considerably in residue according to the quality and source of seed and the method of crushing. The amount of residue remaining in a core made from a given quantity of oil and sand governs the strength of the core and its liability to blow. The stronger a core can be made with a minimum amount of residue the better, because a higher percentage of residue in the baked core means more gases given off during casting. One substitute for linseed gives off 33⅓ per cent. less gas during casting and entirely obviates blows. In the manufacture of core oils tests should be made and records kept of every mixing in order to ensure uniformity.

As to the mixing of oil and sand, in our opinion a special kind of mixer is essential. Every particle of sand should be covered to get the best results. Whilst a sand mill does this, it also powders or crushes the sand, making it close, and thus robbing it of its venting possibilities.—Yours, etc.,

"PNEULEC" MACHINE COMPANY, LIMITED,

Catalogues Received.

Cast Iron Pipes.—The November list of cast iron pipes in stock has now been issued by the Staveley Coal & Iron Company, Limited.

Oil Engines.—Messrs. Vickers-Petters, Limited, of Ipswich, has sent us a brochure illustrating their works, including views of the pattern shop, foundry and machine shops.

Mechanical Stokers.—We have received from Messrs. Power House Components, Limited, of Albion Chambers, King Street, Nottingham, a brochure descriptive of the arrangements and details of the Pluto Stoker for steam boilers.

Machine Cut Gearing.—Messrs. Crofts (Engineers), Limited, of Bradford, have sent us their new catalogue on gearing. The brochure deals successively with spur, bevel, worm and skew gears. Details of their accessories used in connection with gearing are also outlined. Much useful information is given under the final section bearing the caption "Gearing Data."

Core Binders.—Messrs. H. Lionel Tydeman & Company, of Botolph House, Eastcheap, London, E.C.3, have sent us a pamphlet, published by the principals, Messrs. The American Homing Company, of 130, North Wells Street, Chicago, relating to Ajax core and facing binder. There are about 35 mixtures given outlining the various proportions of sand, blacking and other materials which are to be mixed with "Ajax" for the preparation of cores and facings for various types of jobs. Some information is given as to the composition and characteristics of American moulding sands.

Antique Firebacks.—In a beautifully illustrated brochure, which we have received from Messrs. George Wright (Rotherham), Limited, Burton Weir Works, Rotherham, it is stated that the Burton Weir collection of antique firebacks is considered one of the best in the country, as it not only contains examples of the Sussex backs, which are usually wider than their height, but also many of Flemish, Dutch and French origin. The catalogue gives some forty excellent illustrations of these. Any of our readers who are sufficiently fortunate as to receive a copy of this will undoubtedly prize it, as it will forcibly remind them of the artistic aspect of their trade.

Publications Received.

The Foundryman's Educator. By Arthur Greaves. Published by Messrs. Edwards & Bryning, Limited, Castle Works, Baron Street, Rochdale. Price 6s., post free, from the Foundryman's Education Offices, Harefield Hall, near Manchester.

This little book, containing some fifty pages of text, is written purely from the practical standpoint. Metallurgy is not introduced. The object of the book, as we see it, is to interest the moulder in his work and bring to his notice a correspondence course which the author conducts.

Iron and Steel in Brazil.—A recent Brazilian federal decree granted to the Companhia Siderurgica Belgo-Mineiro, Sabara, State of Minas Geraes, special concessions for a period of forty years provided it complies with certain federal laws with reference to subsidy of steel plants. The company at present has operating one blast furnace and plans to erect another as well as an open-hearth furnace and two rolling mills. The Companhia Electro-Metallurgica of Ribeirao Preto, State of Sao Paulo, reports for the first half of 1923 a production of 1,382 metric tons of electric furnace pig-iron and 2,561 tons of steel from Tropenas converter and electric furnaces.

Sir Robert Hadfield Honoured.

Presentation of Thomas Turner Gold Medal.

An interesting ceremony took place at Birmingham University on Tuesday, October 30, when Sir Robert Hadfield, Bt., F.R.S., gave a lecture on "The History and Progress of Metallurgical Science" to the University Metallurgical Society.

PRINCIPAL GRANT ROBERTSON, during the evening, presented Sir Robert with the Thomas Turner gold medal, founded by a prominent Birmingham manufacturer, who has been a strong supporter of the metallurgical department of the University in honour of Professor Turner, and only to be awarded to metallurgists who have rendered signal service to the science of metals. Principal Grant Robertson stressed the fact that the medal was strictly confined as an appreciation of eminent services rendered to the metallurgical manufacturer and industry, and it was only fitting that it should bear the name of their first Professor of Metallurgy in the University. Both gentlemen, he said, had contributed largely to research work. Sir Robert Hadfield combined in a remarkable degree two things. Firstly, he was the head of a large firm with a world-wide reputation in metallurgical products, and secondly he was a Fellow of the Royal Society in virtue of his original researches and contributions to science; and there were not many great heads of business firms who were also heads of the Royal Society. In asking Sir Robert to accept the medal on behalf of the University, the Principal said it was a recognition of what he had done for science and University education, and he (the speaker) wished to assure him that the gift expressed what those who were most competent to judge felt in regard to his services in those directions.

SIR ROBERT HADFIELD, in acknowledgment, warmly thanked the University for the medal and the Principal for his kind words in reference to his firm and himself. It gave him the utmost pleasure not to address the Royal Society or any other important body, but to come down to speak to a body of young students in whose hands lay the future of the Empire. He should value the medal especially for the kind thoughts and pleasant associations which it represented, especially as that was the first time it had been awarded.

The address was specially interesting in that the firing and piercing effect of capped shells on armour plate was illustrated by cinematograph films, as also was the testing machine operations in regard to manganese steel, the extreme ductility and yet great tensile strength of which was admirably shown. Sir Robert alluded to the fact that it was while Professor Turner was occupied in his researches as to the effect of silicon upon cast iron he himself was engaged in working out his invention of manganese steel. He advocated the appointment of a Minister of Science, and said that 90 per cent. of the principal officials in an important Government Department for educational work had received a classical as distinct from a scientific education, which he thought did not make for all-round efficiency.

PROFESSOR F. W. BURSTALL, Dean of the Faculty of Science, thanking Sir Robert for his address, commented appreciatively on the cinematograph illustrations, and said they had listened with profound interest to one of the great masters of metallurgy. The presentation ceremony did equal honour to Sir Robert and Professor Turner. As a young man it fell to his lot to test the early specimens of manganese steel, and they could imagine the feelings engendered when he said it took half an hour to "pull out," as against twelve per hour of the ordinary specimens. The first sample of manganese steel, however, struck them almost dumb with astonishment, for it was an extraordinary and wonderful material.

PROFESSOR TURNER concluded the meeting by saying the lecturer had gone to exceptional trouble in compiling his most interesting address. Mr. Neville Chamberlain, Chancellor of the Exchequer, was elected an honorary member of the University Metallurgical Society, and it was mentioned that both he and the Premier (Mr. Stanley Baldwin) were students in the metallurgical department of Mason College, out of which the University grew.

American Appreciation of English Reception.

The Secretary of the American Foundrymen's Association (Mr. C. E. Hoyt) has written to the Presidents of the various Branches of the Institute of British Foundrymen, stating that it is their desire to provide some more lasting testimonial of their appreciation of the splendid hospitality shown to them, and they propose to prepare a testimonial for each branch, as well as to all the other organisations who were their hosts.

Reports were received from every member of the party on the splendid time they had. One letter concludes:—"The men of the industry in England have set a lively pace for us, but when we have that proposed International Convention in the States we will do our best to reciprocate in kind."

The President of the American Foundry Equipment Company, Mr. Verne E. Minch, has also written several officials of the Institute of British Foundrymen, thanking them for many kindnesses shown to the members during their visit to England. "I shall always prize the personal contacts that I made during my visit, and I shall look forward with the keenest pleasure in anticipation of renewing them both here and in England. I have a very different idea of the Britisher than I had before I met him on his own ground. It has resulted in deep appreciation, warm admiration, and a lasting friendship for Britons as a people," is a phrase culled from a typical letter.

Foundry Education.

At a meeting of the Sheffield Foundry Trades' Technical Society, held last Monday, Mr. A. E. Hoyland gave a lecture on "Foundry Education and the Training of Apprentices."

The lecturer emphasised the need of making the worker a "master of his craft," and pointed out that the skilled workman received material advantage from his training; he quoted figures showing that a skilled man in the normal expectancy of life received £1,600 more than a labourer during the same period. This advantage of skilled training was also of considerable help to his trade, for it enabled the firms to successfully compete for orders, and indirectly was of advantage to the nation.

Dr. P. Longmuir, who presided, said that in co-operation with the University the Society had arranged a special course of six lectures for foundry workers on "How to read drawings and blue prints," and he believed that the Sheffield Education Committee had now decided to establish a special course of instruction for foundry apprentices.

Foundry Spats.

We have received from Messrs. Lawson, Walton & Company, Limited, of 2, St. Nicholas Buildings, Newcastle-upon-Tyne, a sample pair of foundry spats. They are of good quality leather, and the buckles are of such a character that they will meet the rough usage of foundry conditions. Although the wearing of spats in foundries is not compulsory under the clauses of the Factory Act, their use is invariably recommended by H.M. Inspectors. If foundry proprietors desire to keep their freedom in this respect for all time the best method of doing so is to provide spats wherever it is thought necessary. If it is left to the Home Office it is probable that more pairs than are really necessary would have to be obtained. We trust that the provision of safety clothing will be extended voluntarily in British foundries. We specially draw the attention of steel foundries to this innovation, as from experience, we have found liquid steel much more mobile in finding lace holes than iron.

XUM

Institute of British Foundrymen.

LONDON BRANCH.

The first meeting this session of the London Branch of the Institute of British Foundrymen was held in the rooms of the Institute of Marine Engineers, Minories, London, on Thursday, November 18. Mr. Wesley Lambert, the retiring Branch-President, occupied the chair at the beginning of the meeting.

The minutes of the last general meeting having been read, confirmed and signed, THE CHAIRMAN referred to the fact that the Branch-Secretaryship had changed hands. At the last annual general meeting Mr. H. O. Slater had been appointed Hon. Secretary of the Branch, but since then he had expressed the wish that he might be allowed to resign from that position, on the score that he was living so far away from London that it was hardly possible for him to keep in touch with the work of the Branch. Mr. H. G. Sommerfield had kindly consented to act as Hon. Secretary, and the Branch Council had unanimously accepted his kind offer, subject to the approval of the Branch. Mr. Sommerfield was elected unanimously, and expressed his thanks for the confidence which the members had reposed in him.

THE CHAIRMAN then announced with regret the decease of one of the Past-Presidents of the Institute, Mr. C. Jones, who was known personally to some of the members. He asked the meeting, therefore, to rise in honour of Mr. Jones' memory. The members stood in silence for a few moments.

THE CHAIRMAN, in reminding the members that this was his last appearance in the chair as Branch-President, said he had feelings both of regret and of happiness. Regret, in that he was vacating the chair, and happiness in that he was about to hand over the Presidential chair to such a worthy member of the Branch. He took the opportunity of thanking all the officers and Council for their support during the past year, as well as all the members, who had attended the meetings in such good numbers. He could only hope that Mr. Faulkner's year of office as Branch-President would be as happy as had been his own. He had really thoroughly enjoyed the year he had occupied the Presidential chair.

In inviting Mr. Faulkner to occupy the chair he assured him he could do so with everyone's good wishes. He mentioned that although Mr. Faulkner was Editor of THE FOUNDRY TRADE JOURNAL, members must not think he was purely a literary man. Mr. Faulkner was a metallurgist of some standing, and not only was he a metallurgist, but he had a very good knowledge of foundry practice, especially of electric-furnace melting. He (Mr. Lambert) was sure that, with a man such as Mr. Faulkner in the chair, the members would be guided through their discussions, or anything of a controversial character, in a very able manner. He had much pleasure, therefore, in asking Mr. Faulkner to take the Presidential chair, to which he had been unanimously elected.

PRESIDENTIAL ADDRESS.

MR. V. C. FAULKNER then occupied the chair vacated by Mr. Lambert, and delivered his Presidential address, entitled,

"The Present Position of Some Debateable Points in Foundry Practice."

MR. LAMBERT AND GENTLEMEN,—

I am deeply conscious of the very high honour you have done me in electing me as your President. The policy initiated by your last two Presidents, Mr. Slater and Mr. Lambert, will be continued, since, under their *regime*, undoubted progress has been made. Meetings will be held both on Thursdays and Saturdays, as was the case last session. The lateness in starting the session is due to the visit of the American Foundrymen's Association and the Paris International Congress. There were sixteen in the London party, a number equally as great as that normally attending an ordinary annual conference.

I regret that my position does not enable me to present to you an original address, as I have no facilities for carrying out research work, and I shall confine myself to introducing to your notice some salient points brought out by various workers, which have not received the notice of practical men which their importance warrants.

The Status of the Foundryman.

I trust that members are now completely satiated with long dissertations on the status of the foundryman. Whatever they may have been in the past, it can be now definitely stated that since their national technical organisation possesses a Royal Charter, there no longer remains any doubt about this matter, and if foundrymen will allow the question to die a natural death and assume that they have a status equal to that obtaining in other branches of metallurgy and engineering, the world in general will also take it for granted.

Technical Instruction.

Eleven years ago, the late Mr. Charles Jones, a Past-President of the Institute, put forward the following constructive proposals: — (i) That foundry owners should place a corner of the foundry at the disposal of the local technical school for teaching purposes; (ii) that teachers must use simple language; (iii) that a jobbing foundry is the best place for teaching purposes; (iv) that a Committee should be formed to find methods by which foundry instruction could be placed on a better basis. Committees were formed and London presented a report, but the war probably prevented the best results being obtained. The apprenticeship schemes of Messrs. Hall & Company, of Dartford, and the Metropolitan-Vickers concern, have been ably presented to the foundry public by Mr. H. O. Slater and Mr. Tom Makemson. Both these schemes are excellent in conception, but are not applicable to the apprentice for the small jobbing shop, which still remains, when properly conducted, the best training ground. Other recent constructive proposals are: (i) That the apprentice moulder and the apprentice pattern-maker should, as names, cease to exist, and that the term "apprentice foundryman" should be substituted. The object of this is to remove the difficulty of getting boys into the foundry, for by the new name they may be drafted into any of its departments, including the high-standing pattern-shop. (ii) That all apprentices should periodically, say annually, be interviewed by directors, chief sales manager, the secretary, and other high officials of a company. The object of this is to make the boys realise that they are an essential part of a concern, and it is to these high positions that they are to have in mind, and not merely the job of skilled workman. I do not propose to you that we in London should move in the matter, except to give as much support as we can personally to the Sir John Cass Technical Institute, the Chelsea Polytechnic School, the Northampton Institute, the Woolwich Polytechnic, and any other which may exist. We could, for instance, inform these schools that their students are always welcome at our meetings and that, should they require any special help which we as foundrymen can give them, we shall, I am sure, be only too pleased to do so.

Semi Steel.

Some two years ago I had the audacity to propose the word "Fontoid" to replace the word semi-steel. This word received kind criticism, but no acceptation. This word was a combination of the French word fonte—meaning cast iron—coupled with the Greek ending "oid," meaning "like," or "resembling." Professor Turner's expression "Toughened cast iron," and Dr. Moldenke's term "High test cast iron" are insufficiently conclusive, as synthetic cast iron made from steel turnings in the electric furnace exhibit similar if not enhanced properties of steel steel. Mr. S. G. Smith alludes to steel alloy and Mr. C. J. Stokes to steel-mix cast-iron. These terms contain the disagreeable element associated with the expression semi-steel. If semi-steel is con-

sidered as an adjective qualifying cast iron, the expression is no worse than "Basic iron." "Semi" does not necessarily mean "half," but quite often indicates a range, as in "Semi-bituminous," or "Semi-skilled." If in future lecturers refer to the term semi-steel, as "generally-accepted," instead of "so-called," they will only be bowing to the inevitable. As far as I can trace, I am the only person who has defined semi-steel. The definition evolved is:—Semi-steel cast iron is a cast iron which has had its graphitic structure refined, that is made smaller or granular by the introduction of steel into the charge during its manufacture. Mr. Field, whilst agreeing with the definition, raised a query as to the advisability of introducing micro-structure into a definition. However, this should be no more complicated than was the references to chemical analyses in the definitions of twenty-five years ago.

Pearlitic Cast Iron and Semi-Steel.

Pearlitic cast iron unfortunately has to be defined as cast iron containing an all-pearlite-graphite structure, and made by preheating the moulds to a temperature varying with the section of the casting. However, this German invention cannot stop the manufacture of such an iron in this country, because Prof. Turner, F. J. Cook and J. Shaw (Sheffield) pointed out several years that the highest test to be expected from cast iron is that associated with a combined carbon content of from 0.75 to 0.85 per cent.—virtually all-pearlite-graphite structure. The late Dr. H. Frei, of Messrs. Brown, Boveri & Company, of Baden, Switzerland, pointed out that he could make this material in the electric furnace and guarantee a tensile test of over 20 tons per sq. in. Some 60 tons per week of this material is being made in Baden. All the various writers on this admittedly good material mention high sulphur as either a harmless constituent or a necessary attribute. If the latter is correct, it lays the sulphur bogey.

It is interesting to note that at the last Russian Metallurgical Congress Professors Botchvar and Kaliumkoff suggested that the best type of semi-steel was that which possessed an all-graphite-pearlite structure, and that the best composition is one approximating 3.0 per cent. carbon, of which 0.8 per cent. should be combined. The silicon should approximate 1.1 per cent. and the manganese 0.85 per cent., though their sum could be usefully reduced to 1.75 per cent. It is interesting to compare this with Honegger's supplementary remarks on Dr. Frei's work, previously referred to. He stresses the importance of 3.0 per cent. total carbon and 0.7 to 0.8 per cent. manganese, thus confirming the Russian research workers, but carries his silicon up to 1.5 per cent. Würst and Bardenheuer also state that an all-pearlitic-graphitic structure is to be associated with semi-steel.

Diefenthaler, the inventor of pearlitic cast iron, specifies 3.0 per cent. of carbon, of which 0.85 per cent. is to be combined, 1 per cent. of silicon, 0.7 per cent. of manganese, 0.4 per cent. phosphorus, and 0.10 per cent. S. It is now possible to see the relationship between semi-steel and pearlitic cast iron, but the process for making the latter takes thickness of section of the casting into consideration.

The remarkable concordance between the Russian professors and Diefenthaler's recommendation, together with the general support of other workers, calls for not merely British confirmation, but a definite research made on the whole of its properties. From the Russian side greatly enhanced mechanical strength is mentioned when the material is oil- or water-quenched from temperatures ranging between 600 and 800 deg. C., and from the German side nearly 1 per cent. of elongation has been noted. Both speak of lower Brinell hardness.

Sulphur in Cast Steel.

An examination of the current opinions of this subject reveals a very interesting position. According to the report of Dr. Moldenke's recent Paper read before the Sheffield and Lancashire Branches, the Doctor makes not the slightest reference to the possibility of sulphur being harmless, let alone beneficial, when adequately balanced. Mr. G. K. Elliott, who usually follows a similar trend of thought to the Doctor, gave the impression of "hedging slightly" at the last meeting of the American Foundrymen's Association at Cleveland. He pointed out that the removal of sulphur, at least by the basic electric furnace process, involved the removal of oxides and perhaps other harmful constituents. However, all research work considered, I am of opinion that for the ordinary foundryman sulphur is a distinct and definite menace; to the technically skilled foundryman a nuisance, because of local disturbances, but to the foundryman who has specially studied the question it can be high, yet controlled, and a good servant. When the foundryman hears of outstandingly good results being obtained from high sulphur materials he should regard that material as a special alloy, to which he can ascribe definitely many difficulties in compounding.

Separating Charges in the Cupola.

Dr. Moldenke asserts that usually the foundryman considers that by placing a double charge of coke between different-composition mixtures in the cupola the irons can be kept separate for pouring. He showed that iron melts high up the cupola near the lining. The investigation was carried out by the Bethlehem Steel Company, using Mayari pig-iron which contains 1.20 per cent. Ni and 2.40 per cent. Cr. Four cupola charges, each separated by a double charge of coke, were melted, the data obtained being as follows:—

Charge No.	In Mixture. Per cent. Ni.	Per cent. Cr.
1	0.00	0.00
2	0.12	0.24
3	0.18	0.36
4	0.24	0.48

Charge No.	In Castings. Ni Range.	Cr Range.
1 ...	0.08 to 0.12 ...	0.16 to 0.24
2 ...	0.09 to 0.13 ...	0.23 to 0.37
3 ...	0.08 to 0.11 ...	0.23 to 0.30
4 ...	0.08 to 0.12 ...	0.23 to 0.38

Mr. Gibbs has asserted that he can separate charges in the cupola, but he has offered no definite metallurgical data, such as Dr. Moldenke has put forward. We have privately obtained the opinion of many of the most prominent British foundrymen, and the average of all opinion can be summarised by stating it is practically, though not theoretically, possible to separate charges in small cupolas, but not in large ones.

Long-life Moulds.

Whilst I am not enamoured of the term "long-life moulds," it is difficult to find a term which does not clash with other well-established processes. The term "permanent moulds" has been accepted as expressing metal moulds, whereas long-life moulds are made up of refractory material. It is a development of the method such as was outlined by M. Varlet for slag pots, in which the core and the mould are merely reconditioned by strikle-daubing. Dr. Moldenke dealt extensively with the subject at the last meeting of the A.F.A. The moulds he referred to were iron-backed coated with a thick layer of refractory material, which must adhere firmly to the backing. The thickness depends on the weight of the casting. Kaolin, magnesia, fireclay or bauxite can be used as the refractory material. It must be bonded by a mineral substance such as silicate of soda (water glass). In any case, nothing must be present which will evolve gas. Before each cast the moulds must be smoked with soot. The process is used at the Holley Carburetter Company, and is stated to produce 400 castings of a given kind in one hour. With sand castings it takes eight times the number of man-hours to make an equal number of similar castings.

Following this I have recently received a communication from Germany, which outlines an allied method of making long-life moulds. The patentee claims up to 20 castings from one mould. In the communication the writer says:—

"I am enclosing a circular letter dealing with a new foundry development—long-life moulds. It relates to a special method of moulding which makes possible the manufacture of many castings

from one mould without its reconstruction after each cast. The manufacturing costs show extremely large economies, notably in the case of moulders' wages. On an average the economy amounts to from 50 to 60 per cent., as compared with normal methods. Other economies relate to the smaller quantity of moulding sand used. For instance, if 20 castings are made in one mould, 19 times the normal moulding costs are saved. Again, only the original mould is dried, it being unnecessary to do so for further casts. Cranes are more free, as there is no transport of large moulds to and from the drying-stoves. Obviously there is less wear and tear on the patterns. In Germany the method has been introduced into many of the largest foundries, with distinct success, as is borne out by the enclosed testimonials. The method is not confined to castings of simple form, but is equally applicable to those of complex structure. For the confection of long-life moulds a specially prepared mixture is used which can be made up in the sand-preparing department of any foundry. The bedding-in of the pattern is carried out in the usual way, the material for these moulds being employed similarly to facing sand, 4 in. being mentioned as a suitable depth. The reinforcing of the moulds is effected in the usual manner by gaggers and grids, according to the type of mould. The castings are stated to be of high quality, being always soft., easily machined, and the structure definitely dense. Unsightly pins are eliminated, especially in high-class work, such as cylinders, cylinder covers, pistons, etc."

This is obviously a problem which every foundryman must have considered, yet it is for the States and Germany to lead the way. During the present depression it would be advantageous if every foundry manager and foreman carried out some experiments for himself.

In conclusion, the Branch-President asked that his address should not be considered as a Presidential address in the sense that it could not be discussed, and asked that the members would discuss it and raise any points which struck them as being in any way controversial.

THE BRANCH-PRESIDENT, before throwing the meeting open to discussion, proposed that the very heartiest thanks of the Branch be given to Mr. W. Lambert for the excellent way in which he had carried out his duties as Branch-President. Those who were present at the banquet given to the American delegates recently would agree with him that Mr. Lambert had made a most dignified and excellent Chairman. The duties which he had carried out in connection with that event were arduous in the extreme: there was a tremendous lot of work attached to it, and, without his help, the visit of the American Foundrymen's Association delegates would not have been the success it was. As to the Branch itself, apart from the ordinary Council meetings during the past year, Mr. Lambert had devoted a considerable amount of time to the work of the Test Bar Committee, to the drawing up of the new Branch rules, and also the rules for the general operation of the Institute.

MR. H. COLE ESTEP, seconding, said that, having been associated with Mr. Lambert in the past year or two, and particularly during last summer in connection with the things Mr. Faulkner had mentioned, he knew personally the large amount of time Mr. Lambert had devoted to the advancement of the Institute. It was work which was exceedingly important: the extent of it would never be known, but it would be of great and lasting advantage to the Institute.

The vote of thanks was accorded with acclamation.

MR. WESLEY LAMBERT, in returning thanks, repeated that his year of office had been a very happy year for him. The work that had been alluded to had contributed towards the pleasure he had derived. Mr. Faulkner had alluded to what was done in connection with the entertainment of the American delegates, and he (Mr. Lambert) would like to say that, before their American guests left for America, he was the recipient of a number of communications thanking him, as representing the London Branch, for the entertainment and hospitality extended to them.

THE BRANCH-PRESIDENT then announced with regret that Mr. J. J. McLelland was resigning from the Branch Council, owing to his removal recently to South Wales, though he was not resigning from membership of the Branch. He assured Mr. McLelland, on behalf of the members, that they trusted he would have a very successful time in South Wales.

DISCUSSION.

The Presidential address was then discussed.

MR. HAROLD SHILLITOE said he had heard of the long-life process before the war, but he did not know what the inventor had done during the war or since.

Sulphur in Cast Iron.

MR. J. W. GARDOM, referring to the question of sulphur in cast iron, said he considered that sulphur was nothing like so detrimental as most people would have us believe. Personally, he was rather in favour of it. Very often a very hard cast iron was necessary, and he had found that, for wearing purposes, extra sulphur, up to 0.1 and 0.15 per cent., was better than an extremely low sulphur content, say 0.02 per cent. He was of opinion that the manganese should be high, but not to the extent that Young had spoken of. With regard to machining, all the machining at his works was done piece-work, and he would soon learn of it if it were difficult to machine.

As to permanent moulds, he had been hoping to make his fortune from some of these moulds for five years. He had tried various things, and when the Carborundum bricks came out he thought he had accomplished it. However, it was found after trial that the iron would not go on it. Recently, with the idea of casting malleable iron in a permanent mould, he had used a grey-iron mould, and had quite good results from test bars. He had taken ordinary grey cast iron and blackleaded it well, but there the great difficulty was shrinkage. With malleable iron the shrinkage was about ¼ in. to the foot, and he could not get any feeding into a permanent mould.

Cupola Charges Cannot be Separated.

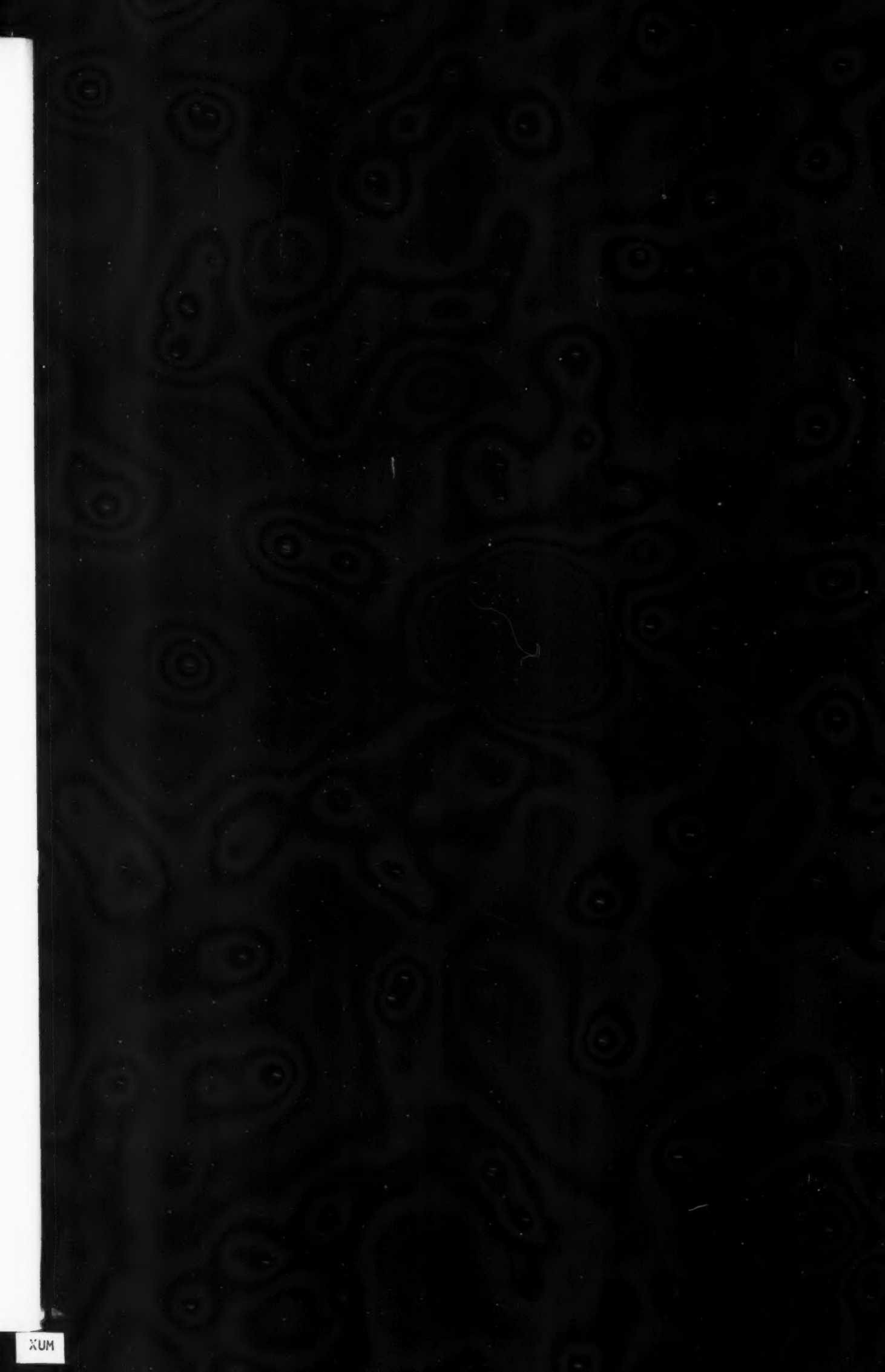
With regard to the mixing of charges in the cupola, he was firmly of the opinion that charges could not be separated by coke; he had tried it. He had not tried it with varying nickel and chromium content, but he had with varying proportions of silicon, from 0.5 to 2.5 per cent., that taking a casting of white iron and going on to grey iron, or casting a grey first and going on to white. He always cast grey iron first, and then went on to the white, but he always waited until the grey iron was completely out before going on to the white iron. Even when separating with as many as six coke charges—which was practically filling up the cupola to the top of the charging platform—he had found the white iron mixed with the grey iron. The cupola in question was only a small one—30 in. He was using, of course, a larger cupola—42 in. The separations had not been tried in that.

MR. SHAW, referring to the composition mentioned in the Paper, namely, 3.0 per cent. total carbon, of which 0.85 per cent. was combined; 1 per cent. Si and 0.75 per cent. Mn, stated that he was of opinion that it was to be associated with the highest tests to be obtained from cast iron, but practical foundrymen were only in a position to control the silicon, sulphur, phosphorus and manganese, leaving it to these elements to control the condition of the carbon.

MR. A. R. BARTLETT, speaking of long-life moulds, said he did not see how contraction could be overcome in a permanent mould. He had only had experience of permanent moulds of simple shape.

THE BRANCH-PRESIDENT said the Paper referred to long-life moulds, which were made of refractory materials, and not permanent moulds.

MR. BARTLETT replied that he had no knowledge whatever of long-life moulds constructed of refractory materials, and had no idea of how to get over the difficulty of contraction with anything that could be called permanent or long life when applied to moulds. Knowing that all metals contract in cooling, it appears that all internal parts of moulds, no matter of what material they may be constructed, must be able to give when the contraction of the casting takes place. If the internal parts of a mould could be constructed on some



Sept. 30th, 1923.

BLAST FURNACES OF THE UNITED KINGDOM

BUILT AND IN BLAST.

Compiled from Returns Received Direct from the Furnaces, and Published at the Offices of

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MIDDLESBROUGH and Newcastle-on-Tyne.
PIG IRON, COALS, COKE.
HOME AND EXPORT.

Total number of Furnaces Built on Sept. 30th, 1923	485
Total number of Furnaces in Blast on Sept. 30th, 1923	189
Decrease in the number of Furnaces Built	3
Decrease in the number of Furnaces in Blast since June 30th, 1923	34

Furnaces Blown-in since June 30th, 1923 — 3

Lincolnshire (1).—Redbourne Hill Iron & Coal Co., Ltd., 1.
Derbyshire (1).—E. P. Davis, Bennerley, 1.
South Staffordshire and Worcestershire (1).—G. & R. Thomas, 1.

Furnaces Blown-out since June 30th, 1923 — 37

Scotland (4).—Wm. Dixon, Ltd., 2; Glasgow Iron & Steel Co., Ltd., 1; Wm. Baird & Co., Ltd., 1.
South Wales (2).—Briton Ferry Works, Ltd., 1; Blaenavon Co., Ltd., 1.
Durham and Northumberland (3).—Palmers Shipbuilding & Iron Co., Ltd., 2; Seaton Carew Iron Co., Ltd., 1.
Lincolnshire (3).—Appleby Iron Co., 1; North Lincolnshire Iron Co., 2.
Cleveland (7).—Gjers, Mills & Co., Ltd., 1; Dorman, Long & Co., Ltd., 2; Pease & Partners, Ltd., 2; Wm. Whitwell & Co., Ltd., 2.
West Cumberland (4).—United Steel Companies, Ltd., 1; Millom & Askam Hematite Iron Co., Ltd., 2; Whitehaven Hematite Iron & Steel Co., Ltd., 1.
North Staffordshire (4).—R. Heath & Low Moor, Ltd., 2; Goldendale Iron Co., Ltd., 1; Shelton Iron, Steel & Coal Co., Ltd., 1.
South and West Yorkshire (2).—Walter Scott, Ltd., 1; Parkgate Iron & Steel Co., Ltd., 1.
Lancashire (3).—Charcoal Iron Co., 1; Barrow Hematite Steel Co., Ltd., 1; Partington Steel & Iron Co., Ltd., 1.
Derbyshire (2).—Denby Iron & Coal Co., Ltd., 2.
South Staffordshire and Worcestershire (3).—M. & W. Grazebrook, Ltd., 1; Alfred Hickman, Ltd., 1; N. Hingley & Sons, Ltd., 1.

Furnaces being built at present time — 10

(See below).

Furnaces being Re-lined at present time — 67

Durham (7).—Consett Iron Co., Ltd., 2; Dorman, Long & Co., 1; Linthorpe-Dinsdale Smelting Co., 1; Seaton Carew Iron Co., 3.
Nottingham and Leicestershire (1).—Stanton Ironworks Co., 1.
Cleveland (19).—Bolckow, Vaughan & Co., Ltd., 8; Cargo Fleet Iron Co., 1; Wm. Whitwell & Co., 1; Dorman, Long & Co., 3; Cochrane & Co., 2; Pease & Partners, 4.
South Staffordshire (4).—Alfred Hickman, 2; G. & R. Thomas, 1; M. & W. Grazebrook, 1.
Staffordshire, North (3).—Robert Heath & Low Moor, 2; Shelton Iron, Steel & Coal Co., 1.
Cumberland (5).—United Steel Companies (Workington), 5.
North Wales (1).—Darwen & Mostyn Iron Co., 1.
Derbyshire (5).—Sheepbridge Coal & Iron Co., Ltd., 1; Clay Cross Co., 1; Denby Iron & Coal Co., 1; Stanton Ironworks Co., 2.
Northamptonshire (2).—Kettering Iron & Coal Co., 1; New Cransley Iron Co., 1.
Lincolnshire (1).—North Lincolnshire Iron Co., Ltd., 1.
Lancashire (7).—North Lonsdale Iron & Steel Co., Ltd., 2; Barrow Hematite Steel Co., 2; Darwen & Mostyn Iron Co., 1; Charcoal Iron Co., 1; Carnforth Hematite Iron Co., 1.
Scotland (6).—Carron Co., 1; Shotts Iron Co., 1; David Colville & Sons 1; Coltness Iron Co., 1; Wm. Dixon, Ltd., 1; Summerlee Iron Co., 1.
South Wales (4).—Ebbw Vale Steel, Iron & Coal Co., Ltd., 2; Guest, Keen & Nettlefolds, Ltd., 1; Blaenavon Co., 1.
South-West Yorkshire (1).—Newton, Chambers & Co., 1.
Shropshire (1).—Lilleshall Co., Ltd., 1.

Scotland.

Name of Firm.	Total in blast on Sept. 30.	In blast Sept. 30 making: Hem.	F'ge. & F'dy.	Basic.	Average in blast: Sept. qr.	June qr.	Total built.	Fires relining
Langloan Iron and Chemical Co., Ltd., Coatbridge	—	—	—	—	—	—	5	—
Coltness Iron Co., Ltd., Coltness	4	2	2	—	4	4	9	1
Dixon, Wm., Ltd., Calder	—	—	—	—	—	—	7	—
Dixon, Wm., Ltd., Govan	2	—	2	—	2	4	6	1
Dunlop, Jas., & Co., Ltd., Tolcross	3	—	3	—	3	3	5	—
Glasgow Iron and Steel Co., Ltd., Wishaw	4	2	2	—	4½	4	6	—
Merry and Cuninghame, Ltd., Carnbroe	—	—	—	—	—	—	5	—
Shotts Iron Co., Ltd. ..	4	—	4	—	4	4	5	1
Summerlee Iron Co., Ltd. Coatbridge	4	—	4	—	4	4	7	1
Baird, Wm., & Co., Ltd., Gartsherrie	7	4	3	—	6	6	12	—
Baird, Wm., & Co., Ltd., Muirkirk	—	—	—	—	—	—	3	—
Baird, Wm., & Co., Ltd., Eglinton	6	3	3	—	6	7	6	—
Baird, Wm., & Co., Ltd., Lugar							5	—
Dalmellington Iron Co., Ltd., Dalmellington	—	—	—	—	—	—	5	—
Merry & Cuninghame, Ltd., Ardeer	3	—	3	—	3	3	5	—
David Colville & Sons, Ltd., Glengarnock	4	—	4	—	4	4½	7	1

Cleveland District.

Name of Firm.	Total in blast on Sept. 30.	In blast Sept. 30 making: Hem.	F'ge. & F'dy.	Basic.	Average in blast: Sept. qr.	June qr.	Total built.	Fires relining
Dorman, Long & Co., Ltd., North Eastern Steel Works	2	—	2	—	2	2	4	1
Gjers, Mills & Co., Ltd.	2	2	—	—	2½	3	5	—
Cargo Fleet Iron Co., Ltd.	2	—	—	2	2	2	3	1
Tees Furnace Co., Ltd.,	—	—	—	—	—	—	3	—
Bolckow, Vaughan & Co., Ltd.—								
Clay Lane ..	—	—	—	—	—	—	4	—
Cleveland, South Bank	4	—	4	—	4	4	5	2
Cleveland Steel Works, Eaton	1	—	1	—	1	1	5	1
Middlesbrough ..	—	—	—	—	—	—	2	1
South Bank	*3	1	2	—	3	3	7	2
Grangetown ..	—	—	—	—	—	—	2	2
Linthorpe – Dinsdale Smelting Co., Ltd. (Linthorpe Iron Works)	2	2	—	—	2	2	6	—
Dorman, Long & Co., Ltd., Newport Ironworks	3	1	2	—	3½	4	7	1
Pease & Partners, Ltd., Normanby Iron Works	—	—	—	—	½	2	3	2
Cochrane & Co., Ltd.	1	—	1	—	1	1	3	2
Dorman, Long & Co., Ltd. Redcar Ironworks	2	—	—	2	3	3	6	1
Pease & Partners, Ltd., Skinningrove	4	—	4	—	4	4	5	1
Pease & Partners, Ltd.,	3	3	—	—	3	3	6	1

Northamptonshire.

Name of Firm.	Total in blast on Sept. 30.	In blast Sept. 30 making: Hem.	F'ge. & F'dy.	Basic.	Average in blast: Sept. quarter	June quarter	Total built.	Fires relining
New Cransley Iron Co...	1	—	1	—	1	1	2	1
Executors of P. Phipps, Hunsbury Hill Iron Works	—	—	—	—	—	—	2	1
United Steel Companies, Ltd, Wellingboro'	1	—	1	—	1	1	4	—
Islip Iron Co., Ltd., Thrapston	2	—	2	—	2	2	4	—
Kettering Iron and Coal Co., Ltd., Kettering	2	—	2	—	2	2	3	1
Wellingboro' Iron Co., Ltd., Wellingboro'	1	—	1	—	1	1	3	—
Lloyd's Irousions Co., Ltd.	2	—	1	1	2	2½	3	—
Totals	9	—	8	1	9	9½	21	2

South Staffordshire and Worcestershire.

T. & I. Bradley, Ltd (Capponfield)	—	—	—	—	—	—	2	—
Bradley & Foster, Ltd., Darlaston	—	—	—	—	—	—	2	—
G. & R. Thomas, Hatherton	1	—	1	—	1	1	2	1
Earl of Dudley, Brierley	1	—	1*	—	1	1	4	—

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Carron Co., Carron	3	—	3	—	3	3	4	1
Totals ..	44	11	33	—	43½	46½	102	6

North Wales.

Brymbo Steel Co., Ltd.	1	—	—	1	1	1	1	—
Darwen & Mostyn Iron Co., Ltd., Mostyn	*2	—	—	—	2	2	3	1
Totals	3	—	—	1	3	3	4	1

*Two furnaces making ferro-manganese, etc.

South Wales & Mon.

Briton Ferry Works, Ltd.	—	—	—	—	—	1	2	—
Briton Ferry								
Baldwins, Ltd., Cwmavon Works, Glamorgan	—	—	—	—	—	—	2	—
Baldwins, Ltd., Swansea Hematite Works, Landore	—	—	—	—	—	1	2	—
Baldwins, Ltd., Margam	2	—	—	2	2	1	2	—
Crawshay Bros. (Cyfarthfa), Ltd.	—	—	—	—	—	—	5	—
Guest, Keen & Nettlefolds, Ltd., Dowlais	2	2	—	—	2	2	4	—
Guest, Keen & Nettlefolds, Ltd., Cardiff	1	1	—	—	1	1	4	1
Guest, Keen & Nettlefolds, Ltd. (Cwmbran, Mon.)	—	—	—	—	—	—	1	—
Blaenavon Co., Ltd., Blaenavon	1	1	—	—	1½	2	3	1
Ebbw Vale Steel, Iron and Coal Co., Ltd.	3	2	—	1	2½	2½	9	2
Pyle & Blaina Works, Ltd.	—	—	—	—	—	—	2	—
Totals	9	6	—	3	9	10½	36	4

Durham and Northumberland.

Dorman, Long & Co., Ltd., Carlton Iron Works	*2	—	—	—	2	2	3	1
Dorman, Long & Co., Ltd., Clarence Works	2	—	—	2	2	2	11	—
Consett Iron Co., Ltd., Blackhill	3	3	—	—	3	3	8	2
Palmers Shipbuilding and Iron Co., Ltd., Jarrow	—	—	—	—	—	2	5	—
Linthorpe-Dinsdale Smelting Co., Ltd., Middleton	†3	—	—	—	3	3	4	1
Seaton Carew Iron Co., Ltd., West Hartlepool	1	—	—	1	1½	2	4	3
Pease & Partners, Ltd., Tees-Bridge Iron Wks.	—	—	—	—	—	—	3	—
Weardale Steel, Coal and Coke Co., Ltd., Tudhoe Furnaces, Spennymoor	—	—	—	—	—	—	2	—
Totals	11	3	—	3	11½	14	40	7

*Two furnaces making ferro-manganese, etc.
†Three furnaces ditto.

Lincolnshire.

Appleby Iron Co., Ltd., Frodingham	3	—	—	3	3	4	4	—
Frodingham Iron and Steel Co., Ltd., Doncaster	3	—	—	3	3	3	4	—
Redbourn Hill Iron and Coal Co., Ltd.	4	—	—	4	3	2½	4	—
North Lincolnshire Iron Co., Ltd., Scunthorpe	—	—	—	—	1½	2	3	1
Trent Iron Co., Ltd., Scunthorpe	2	—	—	2	2	2	3	—
John Lysaght, Ltd., Normanby Park Steelworks, Scunthorpe	5	—	—	5	4½	4½	5	—
Totals	17	—	—	17	17	18	23	1

Notts. and Leicestershire.

Bestwood Coal and Iron Co., Ltd., near Nottingham	2	—	2	—	2	2	4	—
Stanton Ironworks Co., Ltd., Ashby	3	—	3	—	3	3	4	1
Totals	5	—	5	—	5	5	8	1

Shropshire.

Madeley Wood Co. ..	—	—	—	—	—	—	3	—
Lilleshall Co., Ltd. ..	2	—	—	2	2	2	3	1
Totals	2	—	—	2	2	2	6	1

Tees Ironworks								
W. Whitwell & Co., Ltd.	—	—	—	—	1½	1½	3	1
Totals ..	28	7	16	4	32½	34	73	19

NOTE:—Basic heading includes furnaces making Cleveland pig-iron for steel-making purposes.
* One furnace making ferro-manganese, etc.

West Cumberland.

United Steel Companies, Ltd., Harrington, Derwent Solway, Moss Bay, Workington.	6	5	—	—	7	6½	18	5
United Steel Companies, Distington	—	—	—	—	—	—	3	—
Millom & Askam Hematite Iron Co., Ltd., Millom	1	1	—	—	1	3	6	—
Whitehaven Hematite Iron & Steel Co., Ltd.	—	—	—	—	—	2	3	—
Totals	7	6	—	—	8	11½	30	5

* One furnace making ferro-manganese, etc

North Staffordshire.

Midland Coal, Coke and Iron Co., Ltd., Apedale	2	—	1	1	2	2	5	—
R. Heath & Low Moor, Ltd., Stoke	—	—	—	—	½	2	5	2
Goldendale Iron Co. ..	—	—	—	—	½	1	2	—
Stafford Coal and Iron Co., Ltd.	3	—	3	—	3	3	4	—
Shelton Iron, Steel and Coal Co., Ltd., Stoke	2	—	—	2	2	3	4	1
Totals	7	—	4	3	8	11	20	3

South and West Yorkshire.

Walter Scott, Ltd., Leeds Steelworks	1	—	1	—	1	1½	4	—
R. Heath & Low Moor, Ltd.	*1	—	1	—	1	1	2	—
Parkgate Iron and Steel Co., Ltd.	1	—	—	1	1½	2	3	—
Newton, Chambers & Co., Ltd., Sheffield	2	—	2	—	2	2	3	1
Yorks Iron and Coal Co., Ltd., Leeds	2	—	2	—	2	2	4	—
Wm. Woodhead & Son, Ltd., Bradford	—	—	—	—	—	—	1	—
Totals	7	—	6	1	7½	8½	17	1

*Cold Blast.

Lancashire.

Millom & Askam Co., Ltd., Askam	—	—	—	—	—	—	1	—
Charcoal Iron Co., Ulverston (Backbarrow)	—	—	—	—	1	1	1	—
Barrow Hematite Steel Co., Ltd.	2	2	—	—	2	3	8	2
Carnforth Hematite Iron Co., Ltd., Carnforth	1	1	—	—	1	1	3	1
Darwen & Mostyn Iron Co., Ltd., Darwen	*1	—	—	—	2	2	2	1
Wigan Coal and Iron Co., Ltd.	†2	—	—	1	2	2	5	—
North Lonsdale Iron and Steel Co., Ltd.	2	2	—	—	1½	2	4	2
Partington Steel & Iron Co., Ltd., Irlam, near Manchester	2	—	—	2	2½	3	6	—
Totals	10	5	—	3	11	14	30	7

* One furnace making ferro-manganese, etc.
† Ditto " " " "

Derbyshire.

Stanton Ironworks Co., Alfreton	2	—	2	—	2	2	3	1
Butterley Co., Ltd., Alfreton (Butterley Wks.)	—	—	—	—	—	—	2	—
Clay Cross Co.	1	—	1	—	1	1	3	1
Denby Iron and Coal Co.	1	—	1	—	1½	3	4	1
E. P. Davis, Bennerley ..	2	—	2	—	2	2	3	—
Ditto, Erewash ..	—	—	—	—	—	—	2	—
Renishaw Iron Co., Ltd., Chesterfield	1	—	1	—	1	1	1	—
Sheepbridge Coal and Iron Co., Ltd.	2	—	2	—	2	2	4	1
Staveley Coal and Iron Co., Ltd., Staveley and Devonshire Works	6	—	6	—	6	6	12	—
Stanton Ironworks Co.	8	—	8	—	8	8	9	1
Totals	23	—	23	—	23½	24	43	5

Hill								
N. Hingley & Sons, Ltd., Dudley	—	—	—	—	—	1	2	—
Alfred Hickman, Ltd. ..	3	—	—	3	3½	4	5	2
Willingworth Iron Co., Ltd., Wednesbury	—	—	—	—	—	—	2	—
M. & W. Grazebrook, Ltd., Dudley	1	—	1	—	1	2	2	1
Cochrane & Co., Dudley	—	—	—	—	—	—	2	—
Baldwins, Ltd. (Netherton Furnaces)	1	—	—	1	1	1	2	—
Wm. Roberts (Tipton), Ltd.	—	—	—	—	—	—	3	—
The Birchill's Furnaces, Ltd., Walsall	—	—	—	—	—	—	2	—
Totals	7	—	3	4	7½	10	30	4

*Cold Blast.

Gloucester, Somerset, and Wilts.

New Westbury Iron Co., Ltd.	—	—	—	—	—	—	2	—
Totals ..	—	—	—	—	—	—	2	—
GRAND TOTALS FOR UNITED KINGDOM .	189	38	98	42	198	222	485	67

New Furnaces Building (10).

DERBYSHIRE (3):—Stanton Ironworks Co., 2; Renshaw Iron Co. Ltd., 1.
SOUTH STAFFS (2):—Bradley & Foster, Ltd., 1; T. & I. Bradley, 1.
SOUTH WALES (1):—Baldwins, Ltd., 1.
LINCOLNSHIRE (2):—Appleby Iron Co., 2
NOTTS AND LEICESTERSHIRE (1):—Stanton Ironworks Co., Ltd., 1.
CUMBERLAND (1):—Millom & Askam, Hematite Iron Co., 1.

Number of Furnaces in Blast on Sept. 30, 1923.

District.	Average in blast for Quarter.	Total in blast on Sept. 30, 1923	Total in blast on Sept. 30 making		
			Hem.	Forge & F'ry.	Basic.	Ferro-Man., etc.
Scotland	43½	44	11	33	—	—
Durham and Northumberland ..	11½	11	3	—	3	5
Cleveland	32½	28	7	16	4	1
Northamptonshire	9	9	—	8	1	—
Lincolnshire	17	17	—	—	17	—
Derbyshire	23½	23	—	23	—	—
Notts and Leicestershire ..	5	5	—	5	—	—
S. Staffordshire & Worcestershire ..	7½	7	—	3	4	—
North Staffordshire	8	7	—	4	3	—
West Cumberland	8	7	6	—	—	1
Lancashire	11	10	5	—	3	—
South Wales & Mon.	9	9	6	—	3	—
South and West Yorkshire ..	7½	7	—	6	1	—
Shropshire	2	2	—	—	2	—
North Wales	3	3	—	—	1	2
Gloucester, Somerset, and Wilts. ..	—	—	—	—	—	—
Totals	198	189	38	98	42	11
Totals for Previous Quarter ..	222	223	62	103	45	13

Average Number of Furnaces in Blast for the previous Six Quarters.

District.	June, 1923.	Mar. 1923.	Dec. 1922.	Sept. 1922.	June, 1922.	March 1922.
Scotland	46½	39½	32	18½	12½	10½
Durham and Northumberland	14	11½	8½	8	8½	9½
Cleveland	34	32½	24½	21	18½	17
Northamptonshire ..	9½	10	9½	9	6½	6½
Lincolnshire	18	14	11	9½	9	6
Derbyshire	24	19½	17	14½	12	12
Notts and Leicestershire	5	4½	3	3	3	2
S. Staffordshire and Worcestershire	10	7	6½	6½	6	4½
North Staffordshire ..	11	10	9	6	5	5
West Cumberland ..	11½	11	9½	7½	7	5½
Lancashire	14	12	10½	7	7½	7
South Wales & Mon. ..	10½	8	7	9½	9½	7½
South and West Yorkshire	8½	8	7	7	5	4
Shropshire	2	1½	1	1	¼	—
North Wales	3	3	2	2	2	1
Gloucester, Somerset and Wilts.	—	—	—	—	—	—
Totals	222	191½	157½	130	112½	98

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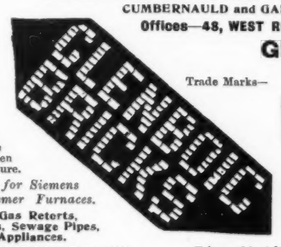

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collapsible principle, then it would be possible to effect the collapse of the internal parts when the casting was set and contraction about to take place; the collapsing parts then being again brought into position when the mould was being prepared for another casting.

Experiments on Long Life Moulds.

MR H. O. SLATER referred to the use of "easing bars" for easing a brass condenser body for one of H.M. ships; these bars were wedge-shaped and something like 8 ft. long.

Instead of making separate moulds, a long-life mould was strickled out in loam. There were only simple castings with a square piece at each end which formed a stand at one end, the other facilitating lifting. Anticipating difficulty with contraction, and being purely an experiment, wooden blocks were inserted as near as was safe to the face of the mould and loamed over. The blocks almost cut the mould in pieces. Directly after casting the blocks were knocked out, giving the desired results, save for a little patching up each time; eight castings were made from the mould.

MR. W. LAMBERT said he thought the composition evolved from the three countries was an ideal one for high test cast iron. So far as the matter had been dealt with from the physico-metallurgical point of view—including the micro-structure and constitutional analysis—such a composition rendered possible an almost ideal metal. He, however, had not personally carried out any experiments with this particular composition, nor could he refer his memory to any castings that he had actually examined which complied with that particular specification. Apart from the Russians, Swiss and Germans, there were investigators in other countries who had done a considerable amount of work, and he believed that, if we had their views on this question, we should find that they quite agreed with the figures.

Oil Sand Cores and Long-Life Moulds.

MR. LAMBERT, speaking with regard to sulphur in cast iron, said he believed Mr. Slater must have melted up very considerable quantities of cast-iron guns within the last few years. The grain of those old cast-iron guns was beautiful, and he knew that the metal contained from 0.1 to 0.13 per cent. sulphur. Also, when he was in the War Department Service he had seen illustrations of permanent moulds for casting cast-iron guns. With regard to the semi-permanent moulds, he had recently in his hands a letter on this question. Experiments had been conducted with moulds made from a mixture similar to that used for oil-sand cores, with a view to constructing semi-permanent moulds. The experiments were not yet completed, but the experimenter stated in his letter that, with one such preparation, 15 casts had been made in one mould without any signs of deterioration. He could not furnish further information until the experiments were completed, but so far the experiments appeared to suggest possibilities in this direction. Mr. Lambert thought it would be interesting to know whether anyone else had experimented with moulds made up in oil-sand core mixtures. Continuing, he mentioned graphite moulds, which were long-life moulds. He had personally tried these experimentally. The moulds were made from spent electric-furnace electrodes. The results of his efforts were not as satisfactory as he could have wished. Some work had been done in this direction in America, and he believed the use of such moulds was covered by an American patent. He asked the President if he could give any information as to the successful application of graphite or carbon moulds either in America or elsewhere.

THE BRANCH-PRESIDENT said that in the North of England experiments had been carried out for some little time with graphite moulds; he had suggested that they should use graphite, but he did not think they had made a success of it.

MR. H. O. SLATER said that most foundrymen were apt to take rather pessimistic views of these experiments, because most of them during their experience had experimented with these things when they had had an opportunity. Castings which could be made in a long-life mould as a rule could be made much more cheaply in ordinary sand, because only the simplest castings could be made in a long-life mould. He recalled making a lead-melting pan weighing two tons. It was found that the bottom of the pan had cracked after it had been heated several times, probably owing to there being an unequal thickness at the bottom. There was a pipe leading off from the bottom of the pan so that the contents could be drawn off when molten.

Owing to the difficulty in getting the pans to stand, a chill was tried with success. It was made in sections to form the bottom and nearly half way up the mould, allowing sufficient distance between the sections to allow for expansion while casting, and that acted as a semi-permanent mould, the remainder of the bottom and top part being struck up in the usual way, provision being made by a good thickness of loam to prevent disturbing the brickwork when lifting the casting from the mould. The casting removed, the loam part, both top and bottom, was dug away to the bricks and loamed again ready for the next casting whilst still warm, thereby saving a good deal of time and expense in drying. The chill was made with a view to efficiency of the casting rather than economy in moulding; it was cheaper to dig away to the bricks each time than to go to the expense of buying or experimenting with refractory materials to withstand several castings. He took a very pessimistic view of the long-life mould.

THE BRANCH-PRESIDENT said that the type of mould which Mr. Slater had referred to was the one that he himself had mentioned for slag pans, which Mr. Varlet had dealt with in his Birmingham Conference lecture.

The Term "Semi-Steel" Unchangeable.

MR. H. COLE ESTEP, dealing with the term "semi-steel," said there seemed to be a great difference of opinion about this name, and various others had been suggested. He had met very many good foundrymen who looked upon the name "semi-steel" with great aversion, and with good reason, but, inasmuch as his country (the United States) was guilty of fastening the name upon the industry, he would defend it. He remembered that at least twelve years ago a very prominent member of the American Foundrymen's Association, who was here last summer, read a Paper entitled "Semi-Steel: a Misnomer," and it was said by the savants of the foundry industry that the term was dead and that it would have to be changed. But it did not die; it had something about it which stuck. He agreed that it was illogical in many ways but no more so than a great many other names one might think of, and it seemed to him that a great deal of time was wasted and a great deal of thought was expended in discussing the question of whether semi-steel should be called "modified cast iron" or something else, and that time and thought might be more usefully employed in studying foundry problems, or the characteristics of this particular metal. He did not know whether it was the opinion of the meeting that "semi-steel" was a proper name or not, but the definition of the material itself was certainly about as comprehensive as he had ever heard. The name, he felt sure, was a permanent fixture in the nomenclature of metallurgy.

MR. A. R. BARTLETT said that this question of long-life moulds was rather irritating him. He had been reading the testimonials which the inventor had been sending round, but they all referred to pistons, cylinder covers, flywheels, etc., and everything that he made had some cylindrical form. He himself could not see that a long-life mould could be made with any intricacies on the outside shape, because, if it were made, how was the casting to be removed and the permanency of the mould to be preserved at the same time? If there were lugs or the like on the outside, then the long-life mould was dead. With regard to flywheels, it was only possible to make the outside of the mould a long-life mould, and a certain amount of taper must certainly be allowed—in fact, rather an excessive amount—which, to his mind, meant an excessive amount of tooling. That was the point which would balance against the possibilities of the saving. Therefore, the only possible saving in making a flywheel would be the possibility of making the outside of the mould permanent. The whole of the inside must be made sectionally, with cores, or there must be some other method of ramming it,

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because how could one get a permanent or long-life mould to stand up against the contraction of a large casting? It must contract and pull against the inside walls of a mould, and unless the walls gave way the casting would certainly break. Mr. Slater had mentioned pans. There was always the possibility, up to a point, if there was a large amount of taper on the pan, but if the pan had only a fair amount of taper on the inside, they would not get it off. He defied anybody to lift it off unless the pan had an excessive amount of taper. He had moulds in the yard at his works which had been in use for twenty years, but he could not cast in them without re-sweeping up the mould. He always put a sort of permanent brickwork inside, reinforced with iron, a matter of about 3 in. smaller than the size of pan required, and that had an excessive amount of taper compared with the inside construction of the pan. He could remove the top plate and the inside brickwork, on condition that he coated the inside building with a straw rope all the way round, in the same way that the normal core barrel was coated. He was making pans under these conditions, but he did not term the mould a long-life mould in the same sense that the German inventor claimed to use it, and he did not think that was the way in which the inventor was claiming to do it. He understood it was only the outside wall of the mould that was permanent, and he gathered that there must be a large amount of taper and that there must be no loose or draw-back pieces. Otherwise there would be drawback pieces of the mould which would come away with the casting and get destroyed. These would need renewing, thus making only a section of the mould long-lifed.

Method Used to Ensure Separation.

As to the controversy with regard to charging different mixtures of metal in the cupola, one man said it could not be done, and another prominent member of the Branch said it could be. He was rather inclined to agree with the man who said it could be done. It was possibly unfortunate for him that he had to try to do it. He did not always get it as he should like to, he would admit, but it was his experience that hard irons melted more easily than soft irons. The usual method was to take the white irons first, because they would melt much faster than the soft grey irons. He charged the furnace with a white iron first, knowing it was easier to get it to run, and preferably ran something in between that iron and the next mixture, because he had found it impossible to get two tons of white iron out and then follow on with, say, a semi-steel mixture, a cylinder mixture, or some other. The usual methd he employed was to charge the two tons of white-iron mixture, put on what he termed a "blank charge"—that was 1½ cwt. of coke—and if he wanted five tons of mixture he would put on probably seven tons. He would take out the first ton and use it for an unimportant job, then take out the five tons that were really wanted, thus leaving another ton in the furnace, to be used for some other unimportant jobs, and so on right through the charges. That was the only way he had been able to satisfy himself that the mixtures had come out at anything like what was expected, judging from the analyses.

MR. J. W. GARDOM, replying to Mr. Bartlett on the question of charging a cupola with different mixtures, said it appeared that Mr. Bartlett was in agreement with his own remarks when he said that the charges could not be separated directly. He quite agreed that it was possible to change gradually from one to the other, but he could not change directly from one charge to another.

THE BRANCH-PRESIDENT pointed out that he had stated, in summarising this question, that it could be done practically, but never theoretically, and he considered that Mr. Bartlett had brought that out fairly well. Mr. Bartlett had questioned whether an intricate casting could be made by long-life mould methods, but Dr. Moldenke, in his Paper, had referred to carburettor castings.

MR. J. J. MCLELLAND said he did not want to enter into the long-life mould controversy particularly, but would give the Branch the benefit of some information which he had obtained since he had been associated with South Wales. He had had the opportunity of calling on one foundry where they very often made propeller wheels in cast iron—usually four-bladed wheels—and he supposed, following up Mr. Bartlett's position, which he thought was pretty well the right one, we ought to introduce the title of semi-long-life moulds. In connection with these propellers, in South Wales they were able to utilise the bottom of the mould for several castings without reconstruction. It went without saying, of course, that in order to get the propeller out of the sand the top part had to be destroyed. Immediately the boss of the propeller had solidified they removed the top part of the mould and took out the casting, leaving the bottom of the mould clear and fresh.

MR. G. HALL, speaking with regard to permanent moulds, said nobody had touched on the question of small castings, except the Branch-President when he had mentioned carburettors. If a permanent mould for a carburettor would cast twenty castings, they had first to produce that mould out of some refractory material, which would cost money. For small work, and particularly carburettors, there were many types of machines, and he considered that a permanent mould made of some refractory material would take a long time to catch up the work that was being done on moulding machines to-day.

THE BRANCH-PRESIDENT said that Dr. Moldenke, in dealing with this had stated that with carburettor castings it took one-eighth the number of man-hours to make an equal number of castings with this method as compared with machine methods.

MR. H. J. MAYBREY expressed the opinion that if there was anything in this permanent mould business he should imagine it had a very limited field, and that only very simple castings could be tackled. He might be wrong, but probably the German gentleman's enthusiasm ran away with him when he had said that intricate castings could be turned out. In any case, the only way in which he should think shrinkage difficulties could be overcome would be by the use of cunningly-placed drawblocks of some sort.

Status Question Re-opened.

MR. C. A. OTTO, discussing the question of the increased status of the foundryman, which was said to be due largely to the fact that the Institution had been granted the Royal Charter, said he was inclined to think that that was an external factor. The increase in the status of the foundryman should come from within, and the apprenticeship question was largely bound up in the condition of that status. Unless we attempted to do something with out apprentices, the status of the foundryman would not be increased in consequence of having a Royal Charter. That was like putting on a new hat or a new coat, and it did not necessarily make any difference to the interior.

THE BRANCH-PRESIDENT said the point he specially wanted to make clear in this connection was that people very largely took it for granted that the foundryman had no status. So long as this desire for an increased status permeated the whole of the British and foreign technical Press, just so long would the engineers imagine that they had a better status than the foundryman. It was time that that died a natural death. If the foundryman assumed he had an excellent standing, then people would believe him.

LANCASHIRE BRANCH.

Propaganda Meeting at Wigan.

Under the auspices of the Lancashire Branch of the Institution a public meeting was held at the Wigan and District Mining and Technical School on October 27 with the object of making the work of the Institution known to those engaged in the foundry trade in Wigan and neighbouring towns. Prior to the meeting a number of the visitors inspected the technical equipment of the College, under the guidance of members of the staff. At the meeting itself there were about 150 present, and the chair was taken by Major T. Walker, of Messrs. Walker Brothers, Wigan. In opening the proceedings, he said he did not think that he was wrong in saying that in the engineering industry to-day no problem called for more serious thought than the production of castings. A few years ago steam engines were made to withstand a pressure of 75 lbs. per sq. in.; to-day makers were asked to provide for pressures of 200 lbs. per sq. in., and in

some cases even 400 lbs. There were difficulties in the way of producing steam-engine cylinders to meet such requirements, and there were other varieties of apparatus which had to withstand extraordinary temperatures and pressures, such as engines which ran on producer gas and similar classes of fuel. So in that way the difficulties of the foundrymen were much greater. Then in the old days the foundry foreman had an extensive practical knowledge of mixtures; he could get certain brands of iron, put them in the cupola, and turn out perfectly good castings. Unfortunately the foundryman of to-day found that, even though he got iron of approximately the same analysis, he could not rely upon getting the same results with it. It might also happen that two consignments of pig-iron would be entirely different in analysis. So it was necessary to go far more deeply into the questions connected with mixtures and other problems of the foundry than was done in the past, and the solution of those problems could only be arrived at by discussion amongst themselves, finding out what others were doing, and learning from their experience. The Institute of British Foundrymen provided opportunities for this interchange of experiences. It did not confine its appeal to the employer or foreman; it appealed to the moulder. During the moulders' strike he saw a statement that a moulder could be made by six months' training. Never in his life had he read anything more futile. During the last few weeks he had watched the growth of a very large mould for a very complicated and difficult casting. Three months were occupied in making the mould, though the actual casting took only a few minutes. To say that a man could have been trained in six months to do that work was utter nonsense. Indeed, there was no tradesman to-day who required more training than the moulder, and in acquiring it, in extending his knowledge of his business, he could get very considerable help from the Institute.

MR. R. A. MILES (President of the Lancashire Branch) gave in brief outline particulars of the history of the Institute since its foundation in 1904, its organisation, and the objects in view. He said the Wigan district was a good field in which to increase the membership of the Institute, and he hoped that result would follow from the present meeting. Increased funds would enable the Institute to undertake more freely research work in connection with foundry matters, and its activities could be beneficially extended by the establishment of additional local branches. His own knowledge of the industry had grown considerably by reason of his membership, and the circle of his personal friends had widened, and foundrymen would understand the advantage of knowing where to apply for help in solving the points which puzzled them in their own practice.

MR. T. MAKEMSON (Secretary, Lancashire Branch) said most of the members looked back with great satisfaction to the day they joined the Institute, because they had found it extremely helpful. He explained the division of the membership into the classes of members, associate members, associates, and subscribing firms, and gave particulars of the subscriptions payable by each class.

THE CHAIRMAN remarked that Mr. Miles had referred to the possibility of the Institute undertaking research work. Many of them were members of the British Cast Iron Research Association, from which they got admirable advice, and he hoped there would not be any overlapping.

MR. MILES said the members of the Institute got at their meetings the benefit of the experience of those members who carried out research work in their own foundries. It was also connected with the British Cast Iron Research Association, which included many of its members, and in a way was an offshoot of the Institute.

The Greenault Sintering Process.

In the course of the evening MR. S. G. SMITH, of Manchester, gave a lecture entitled, "The Manufacture and Characteristics of Cast Iron." This repeated in great part the information contained in Papers written by Mr. Smith which have previously appeared in THE FOUNDRY TRADE JOURNAL, one entitled "Composition of Cast Iron in relation to Fracture," published in January, 1914, and one entitled "The Smelting of Cleveland Ironstone," published in April, 1919. He dealt briefly with the early history of Cleveland ironstone, and described the processes and apparatus used, the calcining and roasting of the ore, the smelting, the blast furnace, calcining kiln, and various stoves for heating the blast. To this he added an explanation of the Greenault sintering process, which, he said, is now in operation at some of the largest foundries. It might be described as an advanced form of briquetting. Its object, in blast-furnace practice, was to fuse the small, fine ores that otherwise would be wasted and lost or used at a disadvantage. Purple ores, fine ores, small residue, the dust, etc., of other ores, all came under this heading. The plant required included a breeze mill which screened coke breeze down to ¼-in. size, an ore mill which screened the ores ready for delivery to stock bin, feeder hoppers to which the ores and breeze were delivered from stock by overhead cranes and grab buckets. The mixture for sintering was composed of return fines, coke breeze, Rosedale fines, Benisaf ore (purple), pyrites residue, and Benisaf ores. They were thoroughly mixed in a large drum, and the mixture was delivered to run along the track over three pans which were charged with it. The pan was charged with 1 in. of bedding on the bottom bars, over which was mixture 8 in. deep. An ignition hood was then drawn over the charged pan, and creosote oil burners ignited the surface layer of the mixture. At the same time the fan (30 in. in water suction) drew air down through the ignited mixture, and sintering took place downwards throughout the mass of the pan charge. On the completion of the process—which occupied 20 to 25 minutes—the pan was turned over on its hollow trunnions, and the solid cake of sinter fell on breaker bars and down a screen shoot, which allowed the "fines" under ½ in. in size to return to the stock bin and the larger pieces to fall into a standing truck for delivery to the blast furnace.

Sulphur Reduction.

The moisture aimed at was 8 to 9 per cent. for the purpose of balling up the fine particles in the mixture, and thus allowing suction of air at a rapid rate through the charge. The proportion of carbon in the mixture (coke breeze) aimed at was 8 to 9 per cent., the precise amount being determined by practice. The breeze must be under ¼ in. area and of good quality, because combustion must be sufficiently rapid to give a melting temperature. Most of the sulphur was burned away as sulphur dioxide, and a small amount of lime seemed to be essential in the mixture. Silica entered into the process, and ferrous silicate was probably formed. In any case, the flux substances present allowed the mixture to melt, and on cooling to have a cell formation. This cell formation was highly desirable for the blast furnace. A thorough mixing of the constituents was of first importance. The sintered material was charged into the blast furnace with the ordinary charges. It increased the rate of reduction and lessened the amount of fuel required; it also favoured the general good working conditions of the furnace.

Mr. Smith exhibited six boxes containing samples of (1) bedding of Benisaf ore; (2) Rosedale fines (calcined Cleveland ore); (3) Benisaf fines; (4) pyrites residue; (5) mixture for sintering; (6) sinter. The analysis of each was given.

Reverting to the question of irons, Mr. Smith described the various grades, and the influence which carbon and silicon exercised.

Time did not allow any discussion of the lecture.

MR. W. DRYDEN (T. Dryden & Sons, Limited, Preston) proposed a vote of thanks to Mr. Smith, to the Chairman, to the governing body of the College, and others for the part they had taken in presenting this lecture. It was seconded by MR. A. E. S. HOUSE, and carried by acclamation.

In responding, Mr. Smith said he had been rather struck with the Chairman's statement that someone had said a moulder could be made in six months. He had been at the business over forty years and was still a learner, and that would be the experience of every foundryman. The older he got the more he realised that he had much to learn.

XUM

Fine Limits in Foundry Practice.*

By C. Dicken.

The foundry trade is one of the oldest and is often referred to as a trade that is never learnt, as it has so many branches. There are so many factors to control, and when everything has been done to ensure good results, batches of castings may be scrapped. The foundry trade is one in which the human element is of greater importance

FIG. 1.—TIMING-CASE COVER PATTERN. FRONT VIEW.

than in the majority of other trades. When considering castings produced years ago, most foundrymen would agree that they were really samples of fine castings of all classes, but it should be pointed out that in those days efforts were entirely centred upon quality, and little considera-

FIG. 2.—TIMING-CASE COVER PATTERN. BACK VIEW.

tion given to weight or thickness. If the casting had a good appearance and possessed an ample thickness for machining operations, it was considered satisfactory. Metal was cheap and so weight was not important, but to-day foundrymen are concerned if the casting is one half millimetre out, and, in some cases, it is almost a question of

* A Paper presented as a Presidential Audress to the Coventry Branch of the I.B.F

a thousandth part of an inch. The motor industry, especially, calls for fine limits for its castings, and obviously Coventry, being the centre of the industry, is required to make fine intricate castings, almost works of art. The craftsmanship of the foundry is undoubtedly better than a century ago, and it is probable that the foundryman of

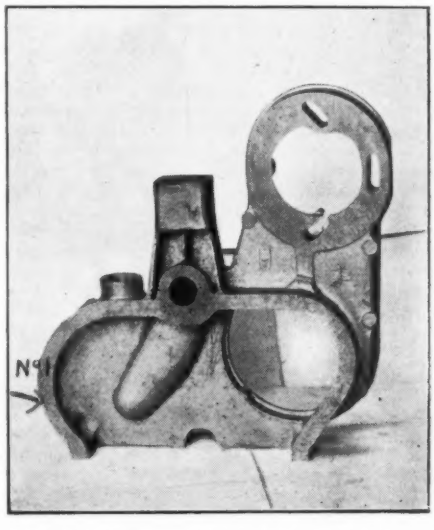


FIG. 3.—TIMING-CASE COVER CASTING. BACK VIEW.

those days would be incapable of making the sections which so often occur in the motor trade.

Of course, the machine shop too has to work to extremely fine limits. Mass production, finer limits and lower costs are aided by jigs, etc. The only method to secure best results from every point, is to conduct the foundry under strict scientific

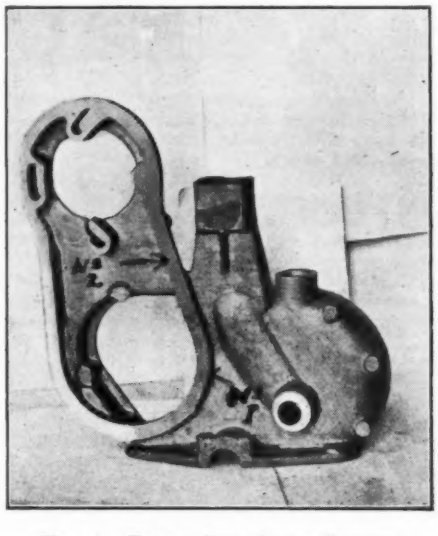


FIG. 4.—TIMING-CASE COVER CASTING. FRONT VIEW.

control. By this is meant the analysis of the component parts of every piece of work. Practical experience has revealed the exact contraction allowance to be given for different alloys. Metals mixed strictly to analysis and cast at a definite temperature by the aid of a pyrometer, cannot fail to produce castings of the most intricate design to within the variation of a 50th part of an inch. Moulding and coremaking machines have been introduced into the foundry to avoid excessive

rapping, and yet it is not essential for all patterns to be put on moulding machines to obtain good results. This is usually decided by the number of castings required. In the automobile trade a pattern is often produced the first time for experimental purposes and is altered from time to time and castings tested from different aspects until it is decided to use the improved pattern to produce a few hundreds and await results. To place some of these patterns upon a moulding machine in the first instance would mean many alterations and great expense, which would not be recovered unless the pattern was adopted as standard.

Sometimes difficulties arise from sand, for too much or too little binder may be present, whilst

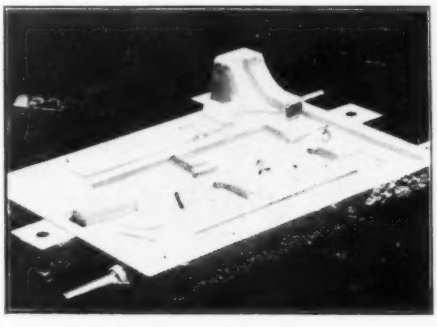


FIG. 5.—MOTOR CRANK CASE. BOTTOM PART.

the quantity of moisture is equally important. A mechanical device has yet to be invented which will assist the foundryman to define the percentage of moisture in sand. In the laboratory and in machine shops, instruments and mechanical devices have been introduced to test the properties of metals, such as those associated with the names of Brinell, Keep, Turner, Schore, and others, but surely a fortune awaits the inventor who will assist the foundryman to test the hardness of a mould.* In the case of an intricate cylinder mould it is sometimes necessary to mix several kinds of sand. Some parts require sand with a very small quantity of binder, and in another part of the mould it is necessary to use sand heavily mixed with binder and, at the same time, using mixtures that will

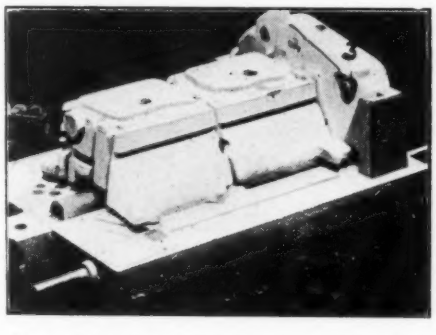


FIG. 6.—MOTOR CRANK CASE. BOTTOM PART OF MOULD, WITH THE CORES IN POSITION.

promote the permeability of the sand so that the gases may escape freely directly the stream of metal reaches the sand.

Timing Case Cover.

Some time ago the author was requested to inspect a timing-case cover, the pattern for which is shown in Figs. 1 and 2. The complaint was serious, as about 25 per cent. of these castings were distorted. Aluminium does not distort, and the suggestion was made that they had been hit when hot and so become distorted. This casting had eleven machining operations. After being placed in the jig, the faces were milled to a depth gauge, shown at No. 1, Fig. 3. The casting is then turned over and placed into another jig, and the face is also milled to a depth gauge from the face (indicated at No. 1 in Fig. 4). Thus, afterwards, when the depth gauge is tried into the inside of the face (see No. 2, Fig. 4) it was found to be 2 or 3 millimetres shallow. Therefore the chain clearance was missing which caused the casting to be scrap. To investigate the case the patternshop foreman was sent for, and the pattern and core-boxes were checked over and were found to be correct. The author supervised the making of a set of cores and also the mould. It was cast, dressed, and machined, and found to be correct. Why should there then be 25 per cent. waste? The author came to the conclusion that it must be the human element. A little later from his office the author heard what he thought to be the excessive rapping of a rapping bar in a pattern. On investigation, it was noticed that the moulder was talking and thinking little of the work he was

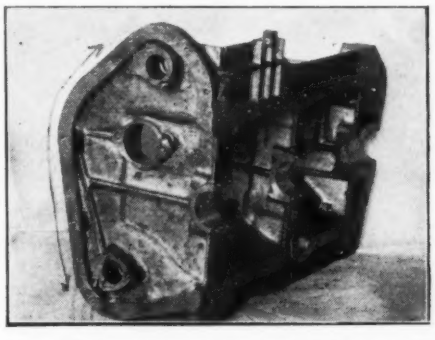


FIG. 7.—MOTOR CRANK CASE CASTING.

doing, and was undoubtedly rapping excessively. This was the solution of the trouble. By excessive rapping, the pattern was kicking from 1 to 2 mm., with the result that the bottom core was laid on its print (Fig. 2) and the top core taking its bearing on core No. 1, Fig. 3, causing an extra thickness of metal on No. 1 face (Fig. 4). It is open to question as to whether this was the better way of moulding such a casting, but that, of course, is controversial. Then, too, it may be thought that a moulding machine would have prevented the 25 per cent. waste, but the number ordered would not permit the expense. The chief viewer or machine shop superintendent can point out the various troubles, but it is seldom possible for him

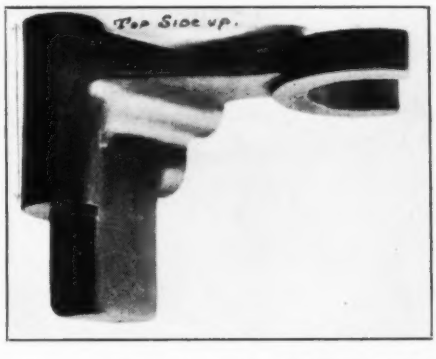


FIG. 8.—MOTOR GEAR BOX STRIKING FORK CASTING.

to assist the foundryman to define the real cause of it.

Motor Crank Case Troubles.

Fig. 5 illustrates a bottom mould of a motor crank case, in which Nos. 1, 2, 3, are the flat prints where the cores are to be placed. This casting required 12 cores. Fig. 6 illustrates the bottom part of the mould with cores erected on it, and Fig. 7 depicts the casting. When these castings were sent from the foundry one could definitely say that they were of the highest quality. They pass through 24 operations. After several of the operations had been carried out, it was found that the flange, indicated by a line in Fig. 7, was 2 mm. thick instead of 5 mm., as stated on drawing. After investigation it was found that the timing end-core (No. 3, Fig. 6) was standing on its end on the flat print (No. 3, Fig. 5). This was a

* An instrument for this purpose was exhibited at the Paris Foundry Exhibition.—ED.

patternshop error, as the end of the core had but one taper put into the corebox to enable the core to leave the corebox clear. This, not being allowed for on the print of the pattern caused the core (No. 3, Fig. 6) to lean outwardly, thus causing the flange indicated in Fig. 7 to be 2 mm. thick instead of 5 after machining.

A Striking Fork Difficulty.

Fig. 8 illustrates a striking fork, used in a gear box of a motor. If the illustration is reversed, the fork is on the flat. This casting passes through nine machining operations, chiefly drilling. The first operation (indicated in Fig. 8) governs many more to follow. Actually this casting turned out badly all over. After an investigation it was found that the jig was made to drawing. The pattern being moulded as illustrated, it was compulsory to have a run of taper from the top arrow to the bottom arrow (marked on illustration), so that the pattern would leave the sand. This was not taken into consideration in the making of the jig on the one hand, and on the other, the casting being placed in the jig, as illustrated, the bottom would stand out 1 mm. more than at the top, and thus when drilled would come out thick and thin. Furthermore, this operation being the starting point for others to follow, caused the casting to turn out a waster.

A few years ago it was general practice to mark out any casting of importance before machining. To-day ideas have changed, and in our most up-to-date machine shops (especially those laid out for mass production) it is considered necessary for castings to be received direct from the foundry dressing shop, and placed immediately into the jig and to be machined correctly. It is the general machine shop opinion that the small percentage of waste caused by adopting this method is far cheaper than marking out. It is recorded that castings 3 ft. 6 in. long have been scrapped because a pimple has happened to be just on the spotting face. The report was " foundry scrap," of course, although it could have been avoided had the operator seen it first. Complaints are sometimes received concerning castings that have apparently proved correct until they have reached the fifth or sixth operation, and it has been found that the first operation caused the trouble. The casting perhaps has a flange and on this flange it has been run with a spray runner. When designing the jig, the designer has forgotten the runner and made the spotting face right on the runner, of course the casting differed according to the dressing. In many cases, it is foundry scrap made at the expense of the improvements of the machine shop. In the United States it is the general practice to make jigs for the foundry, similar to those used in the

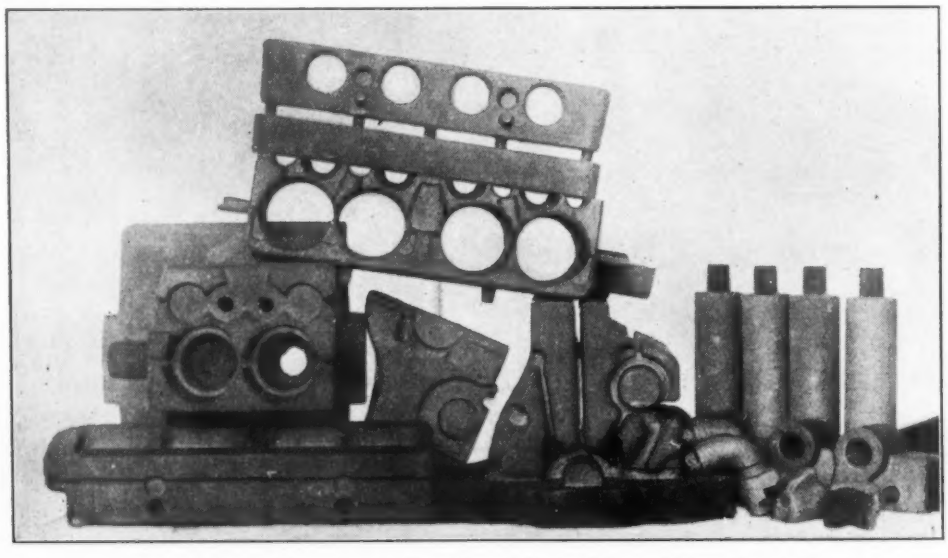


FIG. 9.—SET OF CORES FOR A FOUR-BORE WATER-COOLED MOTOR CYLINDER.

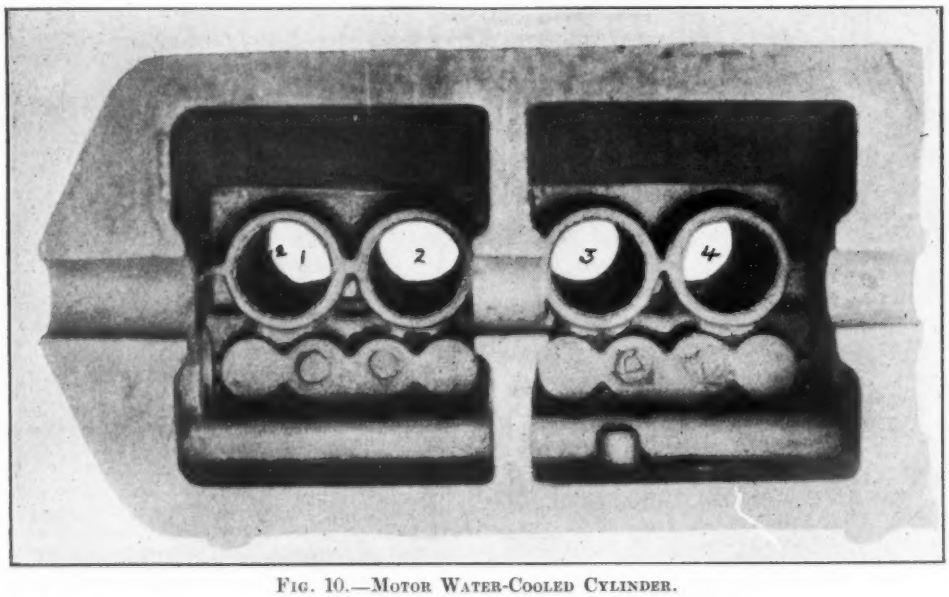


FIG. 10.—MOTOR WATER-COOLED CYLINDER.

machine shop so that each casting may be tried in the jig before leaving the foundry.

The Importance of Jig Making.

If made from drawings, the designer is apt to place spotting faces to come just where the joints of the casting are. This causes trouble. The dresser on the one hand taking a millimetre off, or leaving one on, will often cause wasters. It is always advisable, as far as possible, to avoid spotting from a position made by a loose core. Jig designers would be well advised, if at all possible, to design their jigs from the actual casting and co-operate with the foundry manager.

Water-cooled Cylinder.

Fig. 9 shows a set of cores for a water-cooled cylinder with crankcase combined. They are the 17 cores used in the making of the cylinder illustrated in Fig. 10. The position of this cylinder crankcase gives a full view of the bores. The end of these bores stand about 2 in. in length above the bottom of the crankcase, so that there are, when machined, 4 bores with webs about 6 mm thick and standing above the crankcase about 2 in. in length, just webbed together. It is most important that these cores fit accurately. Every

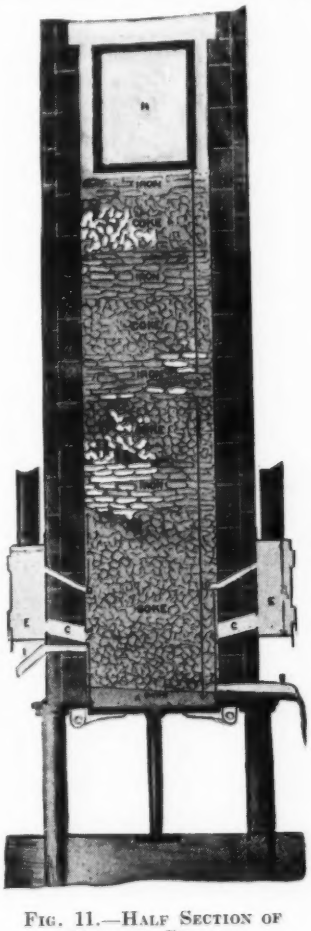


FIG. 11.—HALF SECTION OF CHARGED CUPOLA.

core when placed into the mould is gauged, to make doubly sure that it is in its exact position. If one of these cores, say the barrel core, should be out of position one-fiftieth part of an inch in No. 1 barrel, it would, when machined, cause No. 4 barrel to be 2 mm. out, so that it would result in the walls being 8 mm. thick on one side and 4 mm. on the other; thus, in the end resulting in a waster. An alteration in a core box of 0.5 mm. has been known to change a waster into a good result.

Many years ago, on receipt of an order for 100 cylinders for the motor repair department, the author sent for the pattern and after making inquiries he gave instructions to a moulder, who had previously made these castings, and told him to execute this order. It was ascertained that there had previously been a great deal of trouble in the machine shop. After having one made, and marked off, it was found to be a complete waster. Upon investigation it was ascertained that the prints of the pattern were a few millimetres large, so that the moulder could place the cores into the centre of the print. When the rough casting was cut up, of course, the thicknesses were fine and regular, but when machined they were out altogether. The prints were then made exactly to size so that the cores should fit quite tightly. After this alteration the pattern proved to be wrong. Finally, 2 mm. had to be taken from one side of the pattern and 2 mm. added to the other side. After this had been done the percentage of good castings increased by large numbers. The slightest oversight, such as a particle of sand the size of a pin's head in a bore, or between a valve, will cause a waste cylinder, yet is it not wonderful that these castings after passing through 29 machining operations and tested up to 80 lbs. water pressure will come out at 90 per cent. good results? There is no doubt that after considering the complaints from the machine shop, and thoroughly investigating, a good percentage of the cause of the trouble can be traced to the foundry.

In the motor industry specifications are usually forwarded with the order, and test bars are requested in the case of ferrous and non-ferrous metals. So far no one has been successful in producing a formula for casting temperature to suit different castings; as the casting differs in design so does the casting temperature need to differ, especially in non-ferrous castings.

Cupola Practice.

Fig. 11 depicts the half-section of a charged cupola, and is an illustration of an American cupola taken from West's text book. The bed of coke should be from 18 to 24 in. above the tuyeres, after which is the melting zone. A few years ago, having charge of a class of students, one evening the author was requested by a student to be enlightened concerning furnace trouble. The moulders had finished work, but the iron was unusually late, and a long time in coming down. The foreman had intended to cast early that day and had given instructions for an extra barrow and half of coke to be put into the cupola, but it is obvious that the melting zone of the furnace is definite, and it does not matter how much coke is placed on above the zone, for it must all burn away, and allow the iron to come into that zone before it is melted. It is not to be assumed that the iron would not be hotter, because the extra coke taking so long to burn away allows the metal to get very hot before reaching the melting zone. On the other hand, if the bed of coke is not sufficiently high, or is hollow, then the pig-iron would drop in front of the tuyeres and the result would be disastrous. But the most important part of melting is the accurate time of the melting of the charges, and the correct amount of blast. For instance, in two charges, the silicon content of which has been taken in each case, it is well to consider the different brands of pig-iron and steel constituting it, and yet it is essential that all should be melted, no more and no less, and yet there are charges to follow. If these charges are not timed even to ½ a minute, the test will fail. The author has timed his furnaces for years and taken test bars from every charge and runners from important castings, such as automobile cylinders, and yet he has not erred more than 0.002 per cent.

This method is just as essential for malleable iron foundry as for grey, and, of course, the time it takes to melt a charge is only learned by experience.

A suitable mixture for cylinder iron is as follows:—

Silicon.	*Cwts.*	
1.45 per cent. Scotch	2	2.90
2.74 per cent. Lincolnshire	3	8.22
.25 per cent. Steel Scrap	2	.50
1.6 per cent. Cylinder Scrap ...	3	4.80
	10	16.42

1.642 per cent. Silicon.

Heating Cast-Iron Rolls Electrically.

Before a meeting of the Iron and Steel Works' Electrical Engineers in the United States, MR. GORDON FOX (Electrical Engineer, Freyn, Brassert & Company) read a Paper on this subject, in which he pointed out that the finishing rolls of practically all sheet and tin mills are made of cast iron. In order that the working surface may have sufficient wearing qualities this portion of the roll is cast in an iron mould which causes the molten metal adjacent thereto to solidify quickly. The carbon in this rapidly-cooled iron remains in its combined state. The chilled portion of the roll has a white crystalline structure and is hard and brittle. The clear chill ordinarily has a depth of about ½ in. to 1 in. which tapers off gradually. The entire centre portion of the rolls, including the necks and wobblers, is grey iron which has been cooled sufficiently slowly to permit the carbon to assume a graphité form.

FIG. 1.—DIAGRAM SHOWING STRESSES IN FINISHING ROLL.

This composite structure of the rolls is primarily responsible for roll breakage. The chilled outer portion of the roll has an expansion rate about twice as great as the inner grey-iron portion. Thus the dimension *A*, Fig. 1, tends to expand twice as rapidly as dimension *B*. This may cause shearing stress along some such line as *C*, compression along the line *A* and tension along the line *B*. Similar forces occur in an axial direction. Also, due to the more rapid expansion, the chilled portion tends to pull away from the central portion of the roll, setting up radial tension forces. These conditions would exist even if the roll were uniformly heated. They are decidedly aggravated by the fact that the rolls are heated from the outside and the external portions are permitted to reach fairly high temperatures before the interior is perceptibly heated. The combination of materials having different rates of expansion, heated at different rates and to different degrees, particularly in view of the hard and brittle nature of the chilled metal which is subjected to stress, renders care in the treatment of rolls highly desirable.

The finishing rolls of a sheet mill or tin mill are operated dry and hot. The cooling of the pack thus is minimised. As the hot pack is in contact with the central portion of the rolls, the heat enters the rolls at this point. The ends and necks of the rolls are naturally cooler than the centre as their heat is dissipated through contact with the bearings and otherwise. Moreover, in order to maintain proper lubrication of the roll necks and prevent burning of the grease, water-cooling of the roll ends is ordinarily employed.

In order to obtain sheets having uniform gauge across their width it is necessary that uniform pressure be maintained across the pack as it passes between the rolls. This means that the contour of the upper and lower rolls must be parallel. Due to the fact that the temperature of the centre of the rolls is higher than the ends, the rolls expand more in the centre, increasing their diameter. In order to compensate for this effect, one or both rolls are turned to have a slight concavity of contour when cold. This is termed "crossing" the rolls for the reason that, in turning, the straight roll (or sometimes a straight edge) is placed above the roll to be given concavity. The straight roll is crossed slightly, and the roll being turned is fitted to this crossed roll, resulting in a concave contour.

When the rolls attain working temperature, the expansion causes the straight roll to become slightly convex and the concave roll decreases its concavity to such an extent that uniform gauges are obtained. If a mill has too much concavity it is said to be "hollow" and the pack has horns or fish tails. If the mill is "full" in the middle, the pack is longer in the middle than on the sides and the sheets are rolled thinner in the centre than they are on the edges. Finishing mills are usually operated at temperatures between 550 and 750 deg. Fah. at the hottest point. Tests made by the United States Steel Corporation a few years ago proved that the chilled portion of the roll has the greatest resistance of breakage stresses at about 750 deg. Fah. The strength diminishes only slightly at lower temperature, down to 350 deg. Fah. below which point a material weakening was found. At temperatures above 750 deg. Fah. the strength was found to diminish until, at a temperature of 875 to 900 deg. Fah., which is a low red heat for cast iron, breakage occurred readily under comparatively light stress.

The distribution of heat in the rolls under normal operating conditions is shown in Fig. 2. These temperatures were obtained in a test made at the Vandergrift plant of the United States Steel Corporation from thermo-couples inserted in the top roll, collector rings being supplied to connect with the meter. The mill was rolling light-gauge sheets and care was taken not to exceed safe temperatures. These temperatures probably are representative of good practice. It should be noted that the surface temperatures at points *A* and *C* indicate about 200 deg. Fah. difference.

Due to the fact that rolls are stronger and less brittle at normal rolling temperatures and, further, due to the fact that the rolls have their proper shape only when heated, and, further, to minimise expansion and contraction stresses, it is highly desirable that roll temperatures be maintained as uniform as possible at the best operating point. On fast schedules it is possible to bring the rolls to a dull red heat. In order to restrict roll temperatures to safe limits, it is customary to cool the rolls, either with dry steam or with air.

In starting a cold mill, a number of difficulties are met, as follows—

Due to the fact that the rolls must be raised from a uniform low temperature to a non-uniform high temperature, expansion stresses are inevitable. As the fill is "hollow" until full temperature is attained it is not in best condition to roll wide orders and narrow gauges. It is customary to restrict the orders rolled during the warming-up turn or turns to narrower widths and heavier gauges.

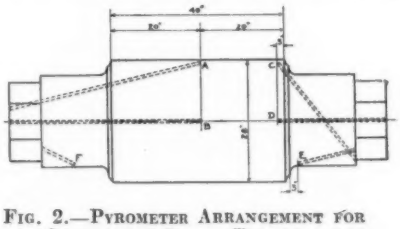


FIG. 2.—PYROMETER ARRANGEMENT FOR OBTAINING ROLL TEMPERATURES DURING OPERATION.

Point A—703 to 736 deg. F.	Point D—378 to 483 deg. F.
,, B—641 to 674 deg. F.	,, E—399 to 447 deg. F.
,, C—510 to 542 deg. F.	,, F—330 to 366 deg. F.

The rolling of narrow iron on the first turns concentrates the wear on the mill to some extent and probably decreases the total wear on wide iron which might be obtained from a set of rolls. Aside from the necessity of warming up the mill, it would seem to be the more desirable practice to roll wide iron during the early part of the week while the surface of the rolls is in the best condition and to roll the narrow iron the latter part of the week after the rolls are worn.

The importance of the question of roll breakage is evidenced by the records of one mill which show that only 15 per cent. of the rolls are discarded due to the fact that they have been dressed down below the chill. The other 85 per cent. are lost through breakage. Some of the rolls serve over 100 days, some serve less than 10 days. The average for the mill mentioned is about 47 days. Rolls which have a deep chill are more sensitive and more subject to breakage than those having a shallow chill. Thus new rolls are more sensitive in this respect than the old rolls which have been repeatedly dressed.

About a year ago, the Inland Steel Company undertook the development of a device for heating the rolls electrically. After a period of experiment,

equipment was evolved consisting of a light angle frame, built in two halves and vertically split, as shown in Fig. 3. Space heaters are used as the heating medium. The heaters used are of special dimensions and rating and somewhat special construction. The heating units are mounted in a flexible member which is attached to the frame. They are suitably backed up by heat-insulating material enclosed between sheet-metal protecting plates. The design has been developed to take care of ordinary variations in diameter of rolls. As shown in Fig. 3, the two halves of the heater are clamped to the stationary rolls, usually after they are in place in the housing. The heating elements make direct contact with the roll surface, thus conveying the heat to the rolls effectively. The heating units do not acquire temperatures more than a few degrees higher than the roll temperature.

The device as originally developed required the service of the crane for its application and removal; but it has been found possible to place wheels

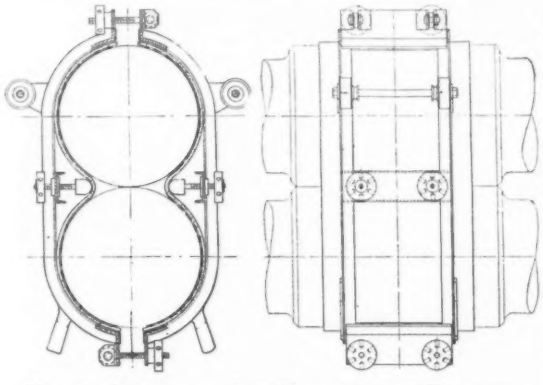


FIG. 3.—FRONT AND SIDE ELEVATIONS OF ELECTRIC HEATER FOR WARMING FINISHING ROLLS.

and handles on the units in such a manner that they may be readily handled, like a truck. Further, means have been devised to enable the heaters to be easily applied without the crane. With certain improvements in design, now contemplated, it is expected that two men will be able to apply or remove the heaters in about five minutes. Tests on a pair of 28 × 44-in. rolls required the continuous application of about 28 kw. of energy for a period of six hours to reach a maximum temperature of 424 deg. Fah. at the centre of the roll face, and 226 deg. Fah. at the end of the roll face. This represents a temperature difference of 198 deg. Fah. which corresponds closely with the temperature difference between these points existing when the rolls are in normal operation.

When cold, these rolls had a maximum separation at the centre of 0.025 in. At the end of the run, after the heaters were removed, the clearance was 0.009 in. Thus two-thirds of the concavity was removed by preheating. This test was made on a pair of rolls which had been dressed to about half the original chill. In view of the fact that the rolls can be brought nearly to normal operating temperatures and shape by electric preheating, there is good reason to believe that practically all limitations both as to character of orders and quantity of output may be safely removed by this practice.

Conditions of Stable Equilibrium in Iron Carbon Alloys.*

By H. A. SCHWARTZ, H. R. PAYNE, A. F. GORTON, M. M. AUSTIN, Cleveland, Ohio.

From time to time one of the authors has had occasion to investigate the graphitising reaction and has published the results mainly as discussion of the work of other investigators. In view, therefore, of the diversity of both observations and interpretation, it seemed well to attempt a revision of the entire subject in the Research Laboratory of the National Malleable Castings Company. The work consisted of a careful study of a single, impure, iron-carbon alloy. The material, which may be considered typical low-carbon white cast iron of the malleable industry, was an air-furnace iron of the following composition:—Carbon, 2.30 per cent.; silicon, 1.20 per cent.; manganese, 0.29 per cent.; phosphorus, 0.156 per cent.; sulphur, 0.048 per cent. The freezing range extended from 1,213 deg. to 1.132 deg. C., the latter figure agreeing with Gontermann's data.

The authors have attempted to define the equilibrium diagram of this alloy, in the stable condition as related to the metastable diagram, from a temperature somewhat below the eutectic freezing point to a temperature below A_{r1} and for graphitic-carbon content from practically nothing to the original total carbon of the specimen. More especially they desired to locate the line in the stable diagram corresponding to the A_{cm} line of the metastable system, which is designated by analogy, the A_{tm} line (t = from temper carbon); also to determine the location of A_{tm} with respect to A_{cm} toward their lower extremities at A_{r1} in order to determine whether or not graphitisation is completed by the separation of an iron-carbon eutectoid analogous to pearlite in the iron-cementite system. This would involve further a comparison of the locations of the stable and metastable A_1 points.

As the carbon concentrations of the solid solutions of the two systems are probably not identical, an explanation of their differences and of the mechanism of their conversion into one another was to be sought. The experimental methods of attack included the following:—

(1) Determination of thermal critical points of stable and metastable alloys.

(2) Microscopic study of solid solutions of the two systems.

(3) Chemical investigation of solubility of carbon in stable system, as related to temperature.

(4) Study of changes in electrical resistance accompanying graphitisation. (5) A few scattering observations incidental to other work that have a bearing on this problem. (6) Preparation and examination of a series of alloys varying progressively in carbon and having otherwise the composition of the hard iron to serve as a means of defining the location of A_{cm}, or at least its terminus at A_1.

The conclusion is reached that the stable and metastable solid solutions are metallographically distinct from one another. The photomicrographs indicate that A_{r1} metastable is below and A_{r1} stable above 750 deg. C., *i.e.*, that the stable critical point is above not below the metastable.

The authors believe that the study of electrical resistance as an expression of the graphitising reaction is novel. It is a most useful means of checking conclusions based on other methods for determining critical points, differentiating between various solid solutions and investigating the mechanism of graphitisation.

Changes of resistance during the process of graphitisation at constant temperature were observed; success in this experiment is possible only if great uniformity of temperature with respect to time and throughout the specimen can be attained. These precautions being taken and stray thermal electromotive forces eliminated, changes of resistance with time were observed and plotted.

In the microscopic examination of many specimens of hard iron in which graphitisation is just beginning, it was observed that the first evidence of the formation of temper carbon is never entirely within a cementite grain, is very rarely in contact with a cementite grain, and is usually entirely within the austenite (mix crystal). Phillips and Davenport present micrographic evidence to this effect. The authors, in common with others, have frequently observed that when graphitisation proceeds below A_1 the temper carbon is entirely surrounded by ferrite. It is common knowledge that the distribution of temper carbon in malleable iron in no way suggests the dendritic structure of the original hard iron.

The conclusion is reached that the solid solutions of the stable system are distinct in structure, electrical properties, and temperature-solubility relation from those of the metastable system. For this new stable solid solution the authors propose the name boydenite, in commemoration of the metallurgist who first practised the graphitising reaction.

* San Francisco Meeting of the American Institution of Mining and Metallurgy.

XUM

Honeycomb Structure in Cast-Iron Welds, with Some Notes on "Burning On."

By S. G. Smith.

The writer was interested in the honeycomb structure of a piece of mild steel, its origin, and explanation that followed, which appeared in the issue of THE FOUNDRY TRADE JOURNAL of September 6.

The following will probably serve an example of a problem not easy to solve satisfactorily. Figs. 4 and 5 show two views of the specimen, Fig. 4 being the front view of the cell structure and Fig. 5 the piece broken through exposing the length of the cells. The writer has had this specimen for some five years, and it is one of many he has possessed and laid aside for future reference. The origin of it is as follows. During the time of his employment at a large engineering factory, who have in their works a number of American-made machines and tools, breakages of these are fairly frequently noted, and it becomes a question of whether the usefulness of the machine can be saved by patching or "burning on"—the foundry term for welding by foundry methods. These machines cannot only with great expense and much loss of time be replaced; as no patterns or drawings exist from which to make new castings, obviously every

FIG. 4.

effort is made to patch or burn on. Consequently, when a breakage does occur, the foundry is consulted as to whether a good repair can be made, and as a rule, no matter how difficult the "burn" or weld may appear, under such circumstances an attempt at "burning on" is generally made.

So far as American- and British-made irons are concerned, there does not appear to be a great difference either in the analysis or the fracture, except that it has been noted that most American cast iron is much softer than the British, which may explain why British physical tests stand higher than American. Possibly the problem now involved may have no relationship to either analysis or fracture. The specimen of honeycombed cast iron illustrated measures 4 in. long by 2 in. deep by 1½ in. wide. Its weight should be, roughly, 50 ozs., but owing to the sponginess it only weighs 42 ozs., which indicates the development of the cell structure.

The analysis of the piece is as follows: Combined carbon, 0.50; graphite, 3.00; silicon, 2.00; manganese, 0.70; phosphorus, 1.00; and sulphur, 0.05 per cent.

The sample represents the result of a first attempt to "burn on" a broken piece from an American machine by British-made iron having the above analysis. It is quite a small piece as compared to the large "burns" that are often made, but it illustrates what occurs in nearly every first attempt to "burn" British upon American iron. It would be interesting to know exactly what occurs to form the numerous cells just where the molten iron adjoins the original casting. The cells are in very close formation, only a thin wall of iron separating them. The cells vary in size from a $\frac{1}{64}$ to a $\frac{1}{4}$-in. diameter, and most of them are from 1 in. to 1½ in. long; there are over one hundred cells formed in the specimen. The bases of the cells are situated at the actual part of the union of the weld, and when it is remembered that a large amount of highly fluid iron has been poured on and flushed over these parts, it does not help the solution of the problem, because the cells must be formed after pouring has ceased, for the top of the "burnt on" piece is quite solid.

The method employed for the "burn" is the same, whether it be for the first attempt or for the second, yet in every instance the second attempt is solid and successful. The author has discussed this phenomenon with metallurgists without receiving any satisfactory explanation. During his long experience he has not known the cell-structure formation to occur when "burning on" British iron to British castings.

The "Burning-On" Process.

Cast-iron welding by the arc, acetylene, or thermit processes, providing the broken casting can be transferred to the foundry, and the position of the repair is get-at-able, provide no better results than the foundry-floor process of "burning on." This applies equally to difficult and risky jobs, and the author's extensive experience has taught him, granted intelligent handling, that if the foundry fails there is little hope for any other process to succeed. Various other methods have been adopted, often unsuccessfully, but it should be distinctly understood there are expert firms who have done many good repairs, and who are gradually overcoming their difficulties.

Practical Considerations.

The first precaution to insist upon is a clean contact area for the molten metal to impinge upon, that is, the surface or parts to be welded must be free from dust or rust, and, where possible, should be rough. A clean yet rough surface is a contributory factor towards a good "burn," and these, coupled with proper pre-heating, are the best conditions for the actual weld to commence.

The walls which confine the "burn" to its position generally consist of loam-cake or milled sand. They should be secure and able to resist any washing away, in case the stream of metal used accidentally plays upon them. This sometimes does happen where it is necessary to move about the stream. The loam or sand must be thoroughly dry to prevent moisture gathering, which may cause a more or less serious explosion.

Pre-heating is necessary with all welding because of the strains set up in the portions adjoining the weld.

The design and contour of the casting is a factor to be considered when pre-heating. Many castings, either from intricate design or imprudent pre-heating, have been irreparably cracked before burning has commenced. Whether pre-heating be done in stoves, by flame, fires, or molten iron, it should be done slowly. The condition of the parts to be welded would be favourable if heated to redness or thereabouts. It is not always practicable to obtain this at the time pouring actually commences, but it certainly should be tried for, as the knitting together of the metal is more quickly started. The metal for welding purposes must be of high temperature and good fluidity.

If the surface of the repair be large, and providing the metal used keeps its "life," it is wise to continue pouring after the broken parts are melted. The condition of melted parts, although not visible, is ascertained by "feeling" rods during pouring.

When making a weld to a depth of 10 to 20 in. in the vertical position, similar to that shown in Fig. 2, channels or run-offs are provided. These are spaced not more than 8 or 9 in. apart, depending, to some extent, upon the weld required. The

FIG. 5.

top surface of any weld should be run off at least half-an-inch above the level of the casting, and if it be a heavy weld not less than ¾ in. should be allowed. By so doing liquid shrinkage is provided for, and softness is obtained on the top allowing of easy chipping or machining.

When a weld is completed it should be slightly covered to prevent the cold air chilling it, and the surrounding parts should remain well covered so as to bring about uniform cooling. Slow cooling after the "burn" is as important as slow pre-heating.

It is often the case when "burning" large castings of complex design, of the type where no other course is open, the result is analogous to a surgical operation being successful but the patient dying, for very often the weld is excellent but the casting cracks at a position near to it.

As a rule, when a good weld has been made, fracture very seldom occurs afterwards in a line with the actual weld, but a crack will sometimes show across the weld, which is due to solid contraction.

Whilst with small simple welds which are a daily occurrence in a large foundry, a small quantity of metal, often less than 100 pounds, would be sufficient, two or three tons may be necessary to effect a large weld. The weight of metal actually welded on, however, bears no relation to the quantity actually required for the job.

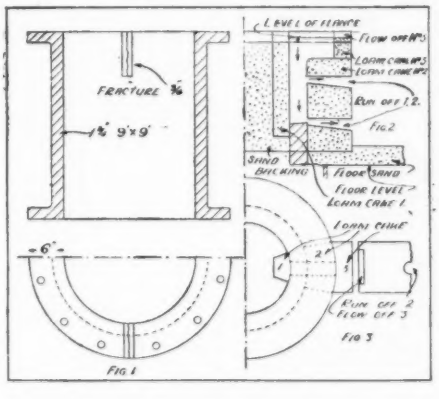
Figs. 1, 2, and 3 depict the method employed when welding a fracture in a large semi-circular flanged piece, actually a part of a condenser, weighing several tons. After being machined and drilled, it was cracked through an accident in the position shown on the sketch. The length of the fracture through the flange and down the body was about 20 in. After putting the casting into a pit, the fracture was opened out by a row of ¾-in. diameter holes, drilled through the flange and down the body to the depth intended to weld. The opening was made continuous—not less than the diameter of the drilled holes ¾ in. wide. Dried loam cakes were shaped to the contour of the casting, fitted to it, and the area of the weld was covered over. The run-offs being provided for, the loam cakes were then blacked and dried. After pre-heating, the loam cakes were finally fitted into their places, backed up with floor sand, and made secure. The pig bed having been previously made for the run-offs to flow into, pouring was commenced in the direction shown by arrow in Fig. 2, and impinged on the bottom of the "burn" near No. 1 run-off. The metal was "played" and poured on this part until a couple of inches of the original casting was melted. No. 1 run-off was then stopped by means of a sand or clay bot. Metal then commenced to flow from No 2 run-off, which was continued until the "feeling" rod indicated that the walls were melted. No. 2 run-off, in its turn, was then stopped. No. 3, the top flow-off, was then operated, until the whole area around the fracture through the flange was in a thoroughly molten condition. The top of the weld was finally well flushed and run off. The amount of highly fluid iron provided for the "burn" was 40 cwt.

Adding a New Part.

The process is one of many which may differ according to the nature of the weld to be effected. Recently a successful "burn" was carried out in the foundry on a casting weighing 20 tons. A thick piece weighing nearly 2 cwt. was accidentally broken off. The actual fracture was about 18 in. wide, and its thickness was between 2 to 3 in. In the preparation for this weld the detached piece was discarded after being used for a pattern to form the shape on the original casting, and the piece "burned on" was entirely of new metal.

Feeling and Feeding Rods.

The feeling rod referred to above must not be confused with the function of the feeding rod. During the progress of a large weld the marked



feeling rods are in continual use to indicate when and how far melting have penetrated into the parts adjacent to the weld and not under direct observation.

DR. W. ROSENHAIN is to lecture before the Institute of Metals (London Local Section) on "Some Impressions of American Non-Ferrous Metallurgy" to-night.

AT THE Sheffield Metallurgists' Society's rooms, Sheffield, on October 3, a lecture was given by Mr. P. M. MacNair, entitled "New suggestions proposed for examining slag metal reactions and their practical application."

MESSRS. HAROLD BENSON, Herbert Benson and D. T. Williams, iron founders, Pontardulais, trading under the style of Harrop, Benson & Company, have dissolved partnership. Messrs. Harold Benson and D. T. Williams will continue the business.

THERE ARE 432 blast furnaces in the United States, with a total rated capacity of 49,000,000 tons per year; of these 59 belong to the Carnegie Steel Company alone and 46 are closely grouped in the Pittsburgh district. In addition to the Carnegie group, there are 27 others operated by Jones & Laughlin, American Steel & Wire, National Tube Company and Pittsburgh Steel, and others, mostly single-furnace operators. This gives Pittsburgh 86 large and modern blast furnaces, with a total productive capacity of nearly 15,000,000 tons of pig-iron per year, or about 30 per cent. of the total for the entire United States. The Pittsburgh group of furnaces average nearly 500 tons per day per furnace, while the average for all others falls below 300 tons per day.

XUM

Trade Talk.

THE PUBLIC WORKS, ROADS AND TRANSPORT CONGRESS AND EXHIBITION is to be held from November 22 to 29 at the Royal Agricultural Hall. As many well-known foundries are exhibiting their finished products, such as steam rollers and crushing plant, it will provide much of interest for our readers.

NICOL INDUSTRIAL COLLODIANS, LIMITED, of Windsor House, Victoria Street, S.W.1, in conjunction with their district agents, Messrs. Lawson, Walton & Company, of St. Nicholas' Building, Newcastle, have held at the Church Institute a demonstration of the uses of Plastic Wood, a material well known to our readers.

AT THE LAST MEETING of the Diesel Engine Users' Association the president (Mr. A. E. Farrow) made the announcement that Mr. Percy Still, who had held the office of honorary secretary of the Association since 1914, had felt obliged to ask the Committee to make arrangements to relieve him of his duties after the end of the current year. The president remarked that when Mr. Still took up the duties of honorary secretary over nine years ago there were about 30 members, whereas at the present day the total membership ran into about 400. The committee were hopeful that before the next meeting of the Association they might be in a position to put forward a suggestion under which the work might be carried out by joint honorary secretaries, and perhaps under such an arrangement the services of Mr. Still might be retained. At the next meeting of the Diesel Engine Users' Association, which is to be held on Friday, November 16, at the Institution of Electrical Engineers, a paper on the subject of "Some Considerations Affecting the Choice of a Heavy-Oil Engine" will be read by Mr. Geoffrey Porter (past-president).

SPEAKING AT THE annual meeting of the Scunthorpe and Frodingham Chamber of Trade, Mr. W. J. Brooke, general manager of the Normanby Park Steelworks, said that in 1919 the output of pig-iron in the Scunthorpe district was 480,000 tons. In May last the output was at the rate of 800,000 tons per annum, and all the furnaces were not then working. If they came to a period of good trade the potential output capacity of the district would be round about 1,000,000 tons. In 1919 264,000 tons of steel were turned out, but last May the output was on the average of 620,000 tons. If every plant in the district were working at its fullest capacity, the output of the district in steel would be in the neighbourhood of 1,000,000 tons each year. Tar macadam works had sprung up in the district, and that was all for its good. Although there was ironstone almost under the public's feet, it was not what could be termed the best. A large amount of fuel was required to turn out the finished article compared with what was required with some stone, and when one considered the high cost of fuel it made the position very difficult indeed. Railway rates were also a very serious matter. The materials which had to be assembled at the local works in consequence amounted to 21s. to 22s. per ton. He could remember when pig-iron was sold at 27s. 6d. per ton. He did not say there was any profit at that price, but he could also remember pig-iron being sold at 40s. per ton, and a fair profit made at it.

HENRY PELS, 40, Great Marlborough Street, London, W.1, have lately supplied heavy cold shears for dealing with billets and slabs to the Shelton Iron, Steel & Coal Company, Limited, of Stoke-on-Trent, the Albert Iron & Steel Company, Limited, of West Bromwich, Robert Heath & Low Moor, Limited, of Stoke-on-Trent, and Kirkstall Forge, Limited, near Leeds, respectively; while a powerful cropping machine designed for dealing with such rolled steel sections as rounds, squares, flats, angles, tees, channels and bulbs has quite recently gone to the Parkgate Iron & Steel Company, Limited. At the moment the firm have in hand two exceptionally heavy scrap shears more particularly designed for dealing with bulky ship scrap, which shears weigh no less than 35 tons, and have guaranteed armour plate frames. These tools have 24 in. gap and 30 in. long shear blades placed on the skew, and each is capable of shearing, plates up to 2 in. thick and flats at one stroke up to 24 in. x 2¾ in. There is a very large clearance of no less than 10 in. between the shear blades, allowing of ship scrap, such as deck and hull plates with channels, zeds, angles, etc., rivetted thereon, being comfortably fed into the shears and thus being sheared off complete without the necessity of having to burn out the rivets first and remove the sections attached to such plates. Messrs. Henry Pels are further building at the moment to the order of a drop forging plant what will probably constitute the heaviest electrically-driven cold shears ever designed, weighing as it does about 70 tons, and being capable of cropping cold billets up to 8 in. square and other bars in proportion.

Personal.

SIR J. C. DAVIES, one of the managing directors of Baldwins, Limited, is seriously indisposed.

MR. JOHN CAMERON, of Messrs. Cameron & Roberton, Limited, of Kirkintillock, a member of the Council of the Institute of British Foundrymen, is sailing for India on November 15. Mr. Cameron has an important commercial interest in a large Indian foundry.

MR. A. A. LIARDET is severing his connection with Messrs. Thwaites Brothers, Limited, of Bradford, to take over the general management of Messrs. Leyland Motors, Limited. As this involves his leaving the Bradford district, Mr. Liardet is resigning his presidency of the West Riding of Yorkshire Branch of the Institute of British Foundrymen.

LIEUT.-COLONEL JAMES PATCHETT, who resides at Haybridge Hall, near Wellington, has been appointed one of the Deputy-Lieutenants for the County of Salop. Colonel Patchett is managing director of the Shropshire Iron Company, Limited. He is also a county alderman and has been a member of the Salop County Council since its formation in January, 1899.

MR. JAMES M. DEWAR, who, as we briefly announced last week, will retire at the end of the year from his position as London director of Cammell, Laird & Company, Limited, will not sever his connection with the industry, as he will still, we understand, continue his work from headquarters in London. Mr. Dewar is widely known in shipping and shipbuilding circles at home and on the Continent as a marine engineer of great skill and wide experience. He did much good work during the war for various departments of State, including the Admiralty, the Ministry of Munitions, and the Disposals Board, and in a variety of other ways he assisted, during the conflict, to maintain the efficiency of the Allied forces, afloat and ashore. His professional life has been closely associated with the development of marine propulsion, extending from the time of the introduction of the water-tube boiler to the recent Diesel-electric device. He served his apprenticeship to engineering on the Clyde, and at the same time attended the Glasgow Technical College, taking numerous honours. On transferring his activities to London he joined the staff of Maudsley, Sons & Field, and from that time identified himself with the development of the Belleville boiler. In 1903 he became London representative of Cammell, Laird & Company, Limited, subsequently becoming London and Birkenhead director. Mr. Dewar is a member of the Institution of Naval Architects, the Institute of Marine Engineers, the Institution of Mechanical Engineers, the Institute of Metals (member of the Corrosion Research Committee), and the Royal Society of Arts, and is a Liveryman of the Worshipful Company of Shipwrights.

Wills.

TOZER, W., a director of Steel Peech & Tozer, Limited, now the United Steel Companies, Limited	£303,959
HIBBARD, J., formerly proprietor of Thomas Staniforth & Company, Limited, makers of agricultural tools, of Sheffield	£13,188
BULLAS, S. W., of Holloway House, Colley Gate, Cradley, founder and principal of S. W. Bullas, Limited	£9,416

Contracts Open.

Aberdeen, November 26.—40-in. diameter cast-iron, mild steel, or reinforced concrete pipes and specials, for the Town Council. The Water Engineer's Office, 41½, Union Street, Aberdeen. (Fee, £5, returnable.)

Dublin, November 13.—Stores, for the Midland Great Western Railway of Ireland Company. The Storekeeper, General Stores Department, Broadstone Station, Dublin. (Fee, 6d.)

Kinghorn, Scotland, November 21.—Supplying and laying about three miles of cast-iron pipes, for the Kinghorn Town Council. Messrs. Crouch & Hogg, 17, Lynedoch Street, Glasgow. (Fee, £1 1s., returnable.)

Southampton, November 12.—114 tons of 12-in. cast-iron pipes and 2 tons of special castings, for the Corporation. The Waterworks Engineer, 21, Shirley Road, Southampton. (Fee, £1 1s., returnable.)

Warrington, November 20.—Stores, during twelve months ending December 31, 1924, for the Cheshire Lines Committee. The Stores Superintendent, Cheshire Lines, Warrington.

Belfast, November 19.—Supply and erection of steam, water and other piping, etc., at the Harbour power station, for the Corporation. Mr. J. Wright, city electrical engineer and manager, East Bridge Street, Belfast. (Fee, £2 2s., returnable.)

Brisbane, March 31.—Self-loading hopper bucket dredger of stern well type. The Department of Overseas Trade.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.

THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS (MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

Company News.

Climax Furnace, Limited.—Capital £100. Director: W. J. Crumplin, 54, New Broad Street, London, E.C.

Stanton Ironworks Company, Limited.—Interim dividend, 4 per cent., tax free.

Anderston Foundry Company, Limited.—Interim dividend, 5s. per share, less tax.

South Durham Steel and Iron Company, Limited.—Dividend, 10 per cent., less tax, for year.

Brunner, Mond & Company, Limited.—Interim dividend, 7 per cent. per annum on ordinary shares.

Nantyglo and Blaina Ironworks Company, Limited.—Dividend, £3 per share, less tax, on preference shares, on account of arrears.

Fairfield Shipbuilding & Engineering Company, Limited.—Profit, £59,105; brought forward, £110,481; debenture interest and preference, £38,750; carried forward, £130,836.

Aluminium Products, Limited, Stanhope Works, Park Street, Camden Town, London, N.W.—Capital £3,000 in £1 shares (2,000 A and 1,000 B). Secretary: E. C. Lewis.

Steel & Company, Limited.—Capital £15,000 in £1 shares, to acquire the business of iron founders, engineers, etc., carried on by Katharine Harriette Steel at Trimdon Street Foundry and Paley Street, Sunderland.

A. W. Calvert (Metallics), Limited, Beck Works, Water Lane, Leeds.—Capital £2,000 in 1,500 ordinary shares of £1 and 1,000 ordinary shares of 10s. Scrap metal merchants. Permanent directors: A. W. Calvert and W. E. Edwards.

Hudswell, Clarke & Company, Limited, Railway Foundry, Hunslet, Leeds.—Capital £100,000 in 10,000 cumulative preference shares of £1 each and 90,000 ordinary shares of £1 each. Locomotive builders, general engineers, etc. Directors: G. W. Butlin, H. Lambert, W. Johnson, and W. W. W. Clayton.

Ibbotson Brothers & Company, Limited.—The fifty-first annual meeting was held at the Globe Steel Works, Sheffield, MR. F. J. TALBOT (chairman) presiding. The report, balance-sheet, and auditors' report were adopted. The retiring directors, Messrs. F. J. Talbot, C. J. Walsh and W. Galloway, were re-elected.

Kayser, Ellison & Company, Limited.—MR. C. W. KAYSER, who presided at the annual meeting on October 26, pointed out that the net profit for the year's working was £5,853 7s. 6d. That amount had been placed to the credit of the profit and loss account, the debit balance being thus reduced to £33,787 3s. 7d., and it was proposed to wipe out that loss by a transference from the reserve fund. Mr. Kayser considered the outlook to be promising, and, notwithstanding the fact that they were not yet working at full pressure, there had been a marked improvement in trade generally. Mr. Harry Fisher, J.P., considered that the figures given in the report were a great improvement on those of last year. There had been a very awkward corner to get round in the steel trade, but he thought the corner was behind them now. One must not lose sight of the fact that trade with the two largest countries in Europe—Germany and Russia—had been at a standstill.

Obituary.

MR. A. BRENNER, of Deutsch & Brenner, Limited, metal merchants, 44, Harford Street, Birmingham, died on October 18, aged 51.

MR. J. E. CLAYTON, secretary for many years to Brown Bros., brass founders, Commercial Street, Middlesbrough, died recently.

MR. G. P. WILSON, J.P., of G. P. Wilson & Son, Limited, ironfounders and engineers, of Northam, Southampton, died on October 18.

MR. C. N. ROBERTS has died at his residence, Fairview, Church-hill, Brierley Hill, Staffs, at the age of 47. He was a member of the well-known firm of ironmasters and timber merchants, of Brierley Hill and Hull, known as Roberts & Cooper, Limited. He was actively connected with the iron side of the business until about three years ago, when failing health compelled him to retire.

MR. CHARLES HOBSON, of Crookesmoor, Sheffield, for many years president of the Sheffield Federated Trades Council, and at one time one of the best known trade union leaders in the country, died on October 28 in his 78th year after a long illness. Born in 1845, he was only 21 years of age when he joined the Britannia Metal Workers' Union, and in 1886 was selected as secretary of a committee appointed to investigate the complaints which had been made in regard to the false marking of goods. He had been for several years a member of the Federated Trades Council, and in 1887 he was appointed President, a position he held for many years. He was the first secretary of the International Metallurgists Congress, and for a long period secretary of the Metal Trades Federation.

Death of Dr. Stead.

We regret to announce the death, which occurred on October 31, of Dr. J. E. Stead, F.R.S., the famous metallurgist. The deceased gentleman, who was 72 years of age, had been ill for a long time, and had not taken any part in public or scientific life for many months.

He was born at Howdon-on-Tyne, was educated privately, and began his industrial career as an analytical chemist under the late Mr. John Pattinson, of Newcastle. On the completion of his apprenticeship he was appointed chemist at the Hebburn works of the Tharsis Sulphur and Copper Company. Shortly afterwards he became chemist to Bolckow, Vaughan & Company, at their Gorton works, near Manchester, and afterwards he went to the same firm's works at Middlesbrough. It was here that he laid the foundations of that vast scientific knowledge which made him the leading authority in metallurgical chemistry, acquiring a thorough acquaintance with all the processes in the manufacture of iron and steel and kindred products.

In 1876 Mr. Stead entered into partnership with his first employer, Mr. Pattinson, and established the Middlesbrough branch of analytical chemists under the style of Pattinson & Stead. In 1905 Mr. Pattinson retired, and Mr. Stead then took into partnership his chief assistant, Mr. H. Frankland, the name of the firm being retained.

THE LATE DR. J. E. STEAD.

His standing as a chemist and metallurgist attracted to his laboratory numerous pupils, many of whom became famous in the scientific world and held responsible positions in some of the largest iron and steelworks in this country and abroad. His principal work in connection with cast iron was the discovery and function of the phosphide eutectic, which profoundly modified previous views held on the fluidity of this material.

In 1895-96 he occupied the presidency of the Cleveland Institution of Civil Engineers; in 1901 he was honoured by the Iron and Steel Institute by the award of the Bessemer Medal. He was a Fellow of the Institute of Chemistry and a member of the Council, and was for many years an examiner in iron and steel manufacture to the City and Guilds of London Institute. Scientific and academic bodies bestowed honours on him. In 1903 he was elected a Fellow of the Royal Society and an honorary member of the American Institute of Mining Engineers. In 1912 the University of Leeds conferred the degree of Doctor of Science, to be followed a year later with the degree of Doctor of Metallurgy by the University of Sheffield, and the Doctorate of Science by the Victoria University of Manchester in 1914. In 1910 he held the presidency of the Chemistry Section of the British Association. The crowning distinction of his scientific career came in 1920, when he was elected president of the Iron and Steel Institute, to the usefulness of which he had contributed so largely.

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XUM

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The improvement in the Cleveland pig-iron industry noted in previous reports is well maintained, while the advance in prices recently announced has apparently stimulated buying for home consumption, some substantial sales on forward account having been negotiated in last week's market. While there is nothing in the nature of a boom, the position is certainly much healthier, and an expansion in the output within the next few weeks would seem to be probable. In the meantime, makers are taking a conservative view, and are anxious to keep the price at a level that will induce a general broadening out of business. Consequently, while 100s. was a minimum quotation for No. 3 G.M.B. last week, and sales were effected at this figure, there was no further advance. At the same time, the generally improved trade outlook and the prospect of a resumption of the shipbuilding industry point to continued firmness and an upward tendency rather than the contrary. No. 1 is extremely scarce, and commands 107s. 6d. per ton, No. 4 foundry is strong at about 99s., and No. 4 forge is obtainable at 97s. 6d. to 98s. per ton.

The market for hematite is stronger, considerable business having been placed both for the home and export market. Home sales, however, predominate, and this is expected to be more marked as the result of the increasing activity in the steel works. There was a brisk demand in last week's market, and mixed numbers advanced by another 6d. per ton to 100s., which brings the price to the level of No. 3 Cleveland. The market shows increasing firmness, and the outlook is regarded with confidence. In West Cumberland and North Lancashire conditions are somewhat quieter, but prices are firmer, Bessemer mixed numbers being quoted at 112s. 6d. delivered Glasgow/Sheffield and 117s. 6d. per ton Birmingham.

MANCHESTER.—The general slackness in the Lancashire foundry industry has, of course, a depressing effect upon the local iron market, in which the principal makers of Derbyshire foundry iron are quoting on a basis of 92s. 6d. per ton at the furnaces, but probably 91s. has not altogether ceased to be accepted. Of course, some of the Derbyshire furnaces are very much clearer of accumulated stocks than others, and amongst these latter are sellers who will not let an order pass them for the sake of 1s. or 1s. 6d. per ton. Local ironfounders do not admit that there has been any improvement in the demands for castings, to correspond with the firmness in pig-iron; but probably there is really some little improvement in this district. At any rate, they are buying iron more freely. The prices for Scotch iron and hematite are rather higher, but one finds very little demand for these irons in the Manchester district.

THE MIDLANDS.—At last week's Birmingham market chief interest was centred in the pig-iron branch following recent developments in the Cleveland area, which has at length stimulated more active buying, mainly on forward account. The effect of the advance in Cleveland quotations has been to induce purchasing on a much freer scale than has been customary of late, and there was an all-round jump in Midland iron prices, which may be averaged at half-a-crown. There was not a lot of business done at this advance. Smelters were quite optimistic, but also very cautious. They are most anxious not to over-commit themselves, but to leave some marginfor any further advances which may occur. In justification of this holding back they point to the very unprofitable prices which have prevailed for so long, and naturally they are anxious to average things up a little. Quotations:—Northamptonshire, 85s.; No. 3 foundry, 92s. 6d.; Derbyshire No. 3 foundry, 92s. 6d., all net f.o.t. furnaces.

SCOTLAND.—More active movements are also reported in the Scottish market during the past few weeks, a fair tonnage of iron having been sold by makers, and had they been willing to take the prices offered the sales could have been substantially greater. No. 3 Scotch remains firm at 102s. at furnaces, and the makers having now good order-books, at least as far as quantity is concerned, are not anxious sellers. With the boilermakers' dispute unsettled, the engineering foundries are still quiet, but some work has come out, and the prospects are somewhat brighter. The Falkirk founders are busy, and most of them have covered their pig-iron requirements till the end of the year, and in some cases to the end of March.

Scrap.

The general tendency of markets for scrap metals indicates a somewhat stronger tone, and in Lancashire, Scotland and South Wales there has been a more active demand for heavy steel, with firmer prices. There is still a scarcity of work amongst ironfounders, and this tends to prevent the price of scrap from rising to its full relative value in relation to pig-iron, but it has made a start. At Glasgow, inquiries for cast-iron scrap continue to be fairly numerous, but sellers are not inclined to book ahead, owing to the uncertainty of the position. With the increased prices being asked for all classes of pig-iron it is quite probable that the demand for cast-iron scrap will increase still more, and this may affect the price. It should be borne in mind, however, that cast-iron scrap has always kept on a fairly high level as compared with other classes of scrap, so that any appreciable increase cannot be looked for, and is undesirable, from many points of view. Heavy machinery cast-iron scrap and scrap railway chairs run about 97s. 6d., and ordinary heavy cast-iron scrap 90s., light cast iron and furnace firebars being at 70s. per ton.

Metals.

Copper.—Conditions in the standard market for this metal continue far from satisfactory, with values maintained at depressed levels. The position may be attributed to an exceptionally poor demand all round, although the fact that fluctuations in values are within very narrow limits would seem to indicate a certain degree of steadiness as far as home trade is concerned. Copper at to-day's quotations is, however, comparatively cheaper than other metals. This metal suffers depression more readily by reason of the unsettled state of Europe than others, but even taking this into consideration the general opinion seems to be that the price is sufficiently low. Current quotations:—*Cash*: Thursday, £60 10s.; Friday, £60 10s.; Monday, £60 15s.; Tuesday, £61 2s. 6d.; Wednesday, £61 5s. *Three Months*: Thursday, £61 2s. 6d.; Friday, £61 2s. 6d.; Monday, £61 5s.; Tuesday, £61 12s. 6d.; Wednesday, £61 15s.

Tin.—Movements in the market for standard tin indicate that the statistical position is regarded as fairly satisfactory, justifying in fact the high levels values have attained within the past month. The backwardation, owing to the apparent scarcity of near tin, has lengthened considerably the margin between cash and three months being now around £3. The home demand has improved considerably, and with renewed buying on American account, together with strong reports from the East, an extension of speculative enterprise in this metal has been encouraged. Sentiment at the moment is optimistic as regards the future course of the market. Although consumption is fairly good, however, the extra quantities coming forward must inevitably weigh on the market, and after the recent sharp advance it would seem that some further reaction may be reasonably anticipated. Current quotations:—*Cash*: Thursday, £208 12s. 6d.; Friday, £208 5s.; Monday, £208 5s.; Tuesday, £213; Wednesday, £216. *Three Months*: Thursday, £205 12s. 6d.; Friday, £205 15s.; Monday, £207 7s. 6d.; Tuesday, £213; Wednesday, £215 15s.

Spelter.—The market for this metal preserves the firm tendency previously noted, due, it may be assumed, in part to the improved demand from consumers, who have purchased large quantities for near delivery, which has resulted in a widening of the backwardation. Though good business transpired on forward account, holders and producers have displayed reserve and the market has been very sparingly supplied. The tendency of values, however, is somewhat lower, owing possibly to a slight loosening by speculative interests in their hold upon the market. Current quotations:—*Ordinary*: Thursday, £33 5s.; Friday, £33 5s.; Monday, £33 3s. 9d.; Tuesday, £33; Wednesday, £33.

Lead.—Business in soft foreign pig is again an outstanding feature in the metal markets, values evidencing remarkable strength with movements favouring still higher levels. A good demand for near delivery has been experienced from both consumers and dealers, to meet which very little metal has been released, and in consequence the backwardation has lengthened to about £3. Under the circumstances sellers of more forward delivery have adopted a very cautious attitude, the apparent acute shortage of prompt metal exercising a restraining influence. Current quotations:—*Soft foreign (prompt)*: Thursday, £29; Friday, £29 10s.; Monday, £30; Tuesday, £29 15s.; Wednesday, £29 15s.